POWER

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ELY C. HUTCHINSON, *Editor*

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Getting a Job

ONE WHO has been my friend since our days at school together sends me the notes of his address on employment.

"Securing employment," he says, "is nothing more or less than selling your services, while selecting your position and securing it is hiring your boss.

"From all the evidence which the writer has been able to obtain any instruction pertaining to selling one's self has never been included in the curriculum of any educational institution, notwithstanding the fact that, in all human possibility, this will be the first and most important commercial transaction which the graduate will ever be called upon to negotiate."

He goes on to say that this is the one type of selling that cannot be learned by experience. He who has real value to offer does not find it necessary to market it frequently, while the acquisition of experience in selling his service evidences the fact that what he is trying to dispose of will not stay sold.

Circumstances do, however, not unfrequently put real merit out of employment, and years of devotion end in the necessity of finding somebody else with a need for real service and who can be convinced of one's ability to render it.

Another friend to whom I had referred a number of applications for positions sends me a copy of the letter received with one of them. It sums up what appears to be a valuable experience and is not lacking in confidence as to the writer's ability. But it winds up, "We could stand New York if the salary was sufficient."

They were actually looking for a man whom it would pay to train for a high position, but the applicant was rejected because he showed no concern for, or interest in, the opportunities that the situation offered to bring him to the front in engineering, but put all the stress on the salary.

Another applicant instead of playing up his aspirations and qualifications, enlarged upon his failure to win appreciation and promotion from his present employers.

The result was the creation of the impression that he was lacking in personality, initiative and persistence. If he was able to convincingly present a good record, cold business instinct would have led his employers to value him much higher than his assistants.

It is a real problem to bring the man who has need of service and the man who has the ability to render it together; to present opportunity to capability and to satisfy a mutual need of service and employment.

F. R. Low

EDITORIALS

Is the Fusible Plug Worth While?

ALTHOUGH the fusible plug was one of the first protective devices placed on steam boilers, its effectiveness is questionable. The fact that high-pressure boilers are not furnished with this device leads one to doubt its usefulness on the less dangerous low-pressure boilers.

Laboratory, as well as operating tests, have indicated the undependability of the fusible plug as a safeguard against low-water damage, and had there been a better understanding and less hysteria in the conditions attending the early boiler explosions, it is doubtful if one would now encounter the fusible plug as a legal requirement. That few explosions have been directly due to a deficiency of water is now a known fact. Furthermore, one plug may fuse when amply protected by water and another may not fuse when raised to a temperature of 2,000 degrees.

A new plug is more sensitive to heat than is a plug after long exposure to the temperature and gases of combustion. This accounts for the requirement in some localities that fusible plugs be renewed annually.

When functioning as expected a fusible plug may cause a greater damage than will low water. For this reason its application to a boiler using gas fuel is discouraged, and in places is prohibited, for the escaping steam will extinguish the gas flame but will not cut off the supply of gas, which may become ignited again after the premises have been filled with it.

The A.S.M.E. boiler code indicates the location of the fusible plug in boilers of various types if the plug is used, but the use of the plug is not mandatory. The code does not advise the use of a fusible plug in a boiler carrying 225 pounds steam pressure, or more, because of the nearness of the steam temperature to the fusion temperature of Banca tin.

A fusible plug must be placed in each boiler intended for operation in Massachusetts unless, because of high pressure or for other reasons, a special dispensation is obtained. However, the Massachusetts Department of Safety has indicated in several opinions filed in specific cases that a fusible plug is not required in those cases where the steam temperature approaches 450 deg. F. The State of Ohio requires the fusible plug providing the pressure does not exceed 225 pounds, but discourages its use with pressures above this. In New Jersey and Indiana, which are A.S.M.E. code states, there are qualifying laws requiring fusible plugs. California, Delaware, Minnesota, Michigan, Maryland, Montana, New York, Oklahoma, Pennsylvania, Rhode Island and Wisconsin are all A.S.M.E. boiler code states where the use of the fusible plug is optional.

Surely, if a fusible plug or other definite low-water alarm is not a necessity in the operation of a boiler that carries 600 or 800 lb. pressure and that evaporates ten pounds of water per hour for each square foot of heating surface, and which will become empty of water if the supply ceases for half an hour, it should not be necessary for any boiler receiving proper operating attention.

Congratulations to the A.S.M.E.

THE American Society of Mechanical Engineers has, in the conduct of its fiftieth anniversary jubilee, set a standard which will long be remembered, not only by the membership, but also by the visitors and guests. Never before has such a distinguished group of world-famous scientists and engineers been assembled for an occasion of the kind.

These men came from homes in this country and faraway to tell of the progress of engineering in their native lands, to emphasize their ideals and speak of the responsibility of engineers to civilization and world culture.

The introduction of the men from abroad by the ambassadors of their countries, when the A.S.M.E. anniversary medals were awarded, was inspiring. The presentation of medals to the six living founder members of the society and the first gift of the Hoover medal to President Hoover, in commemoration of conspicuous public service by an engineer, will long be remembered.

The regret is that more of the younger generation was not present to benefit by absorbing something of the spirit and high purpose of the meetings. It is certain that employers would have benefited far beyond any first cost by having their junior engineers attend the sessions.

Lacking the opportunity of personal attendance, it is hoped that employers and professors in engineering colleges will urge their young men and students to read the proceedings in *Mechanical Engineering.*

There they will find a liberal education and a world concept of their profession of which they will be proud.

The Natural Gas Situation

WHERE is natural gas going from here? It's a brave prophet who dares reply. One may, however, read the sign posts and know somewhat of the general direction.

For years this great national resource, through lack of means for conserving it, has been prodigiously wasted. It has been blown from oil wells into the atmosphere in quantities beyond belief. To be sure, some has been used for fuel, for power, for the production of gasoline, but, important as this consumption is, it has fallen far short of providing a market for the available supply.

In the meantime other things have happened. Cheaper methods have been perfected for the manufacture of pipe and for digging and backfilling the trenches in which to lay it. A growing demand for less smoke is manifest in the centers of industry and in the large cities. Methods of reducing the overproduction of petroleum and its concomitant, natural gas, have engaged attention of experts everywhere. Legislation is being enacted to prevent the sale of oil without a corresponding use of the natural gas that comes with it. It has been found practical to pump natural gas back into the domes whence it came, thus creating a vast underground storage and increasing the oil flow as a result of the added pressure. Generally speaking, a gas pipe line can be installed and maintained for less money than an electric transmission line of the same energy capacity.

In short, by correlating improved practices in seemingly unrelated things, a new economic child is born. What was not possible a few years ago now offers attractive inducement to capital; namely, the marketing of natural gas.

From the Pacific to the Atlantic, from the Rio Grande to the Great Lakes a network of natural gas pipe lines is under way. In some localities natural gas is already being used for steam generation. It is smokelessly producing over 400,000 horsepower in Southern California. It is the present fuel for hundreds of thousands of horsepower from natural gas engines. The completion of numerous lines now under construction will bring natural gas hundreds of miles from the wells to more than a quarter of the population of the United States.

Under these circumstances one may question whether the available supply of natural gas will be sufficient to warrant the vast expenditure of capital involved. Estimates variously place the life of the wells at fifteen to eighty years, dependent upon the locality. It is, however, assured that the natural supply can be augmented as required by gas generated from coal at the mines and from oil at the wells.

So, all things considered, it is evident that the era of gas has begun.

Two Elevators in the Same Hoistway

TOWER-TYPE office buildings have been developed as a solution to the zoning requirements for a "setback" above a definite height. Their artistic proportions and striking appearance give favorable publicity to the owners. On the other hand, reduced floor area of the tower makes it difficult to obtain adequate revenue because of the space required for elevators. It has been suggested that more than one elevator be operated in each hoistway.

At first thought this seems dangerous. People think of a collision between two high-speed elevators running in opposite directions. But why should they run in opposite directions? Subway trains are scheduled on the same track and are kept apart by a block system. The same thing can be done with elevators. They now have fixed limits of travel at the top and bottom, with automatic means to stop the car before it collides with the overhead beams or strikes the bottom of the pit. When another elevator is put in the same hoistway it becomes a limit stop for the car approaching it and collision can automatically be prevented.

An engineering analysis shows no fundamental reason why more than one car cannot be run in the same hoistway. There are problems to be worked out, but when the demand exists a solution will be found. An actual installation of this kind will quickly overcome any popular objection that may exist due to the novelty of the arrangement. The American public is quick to grasp new ideas and approve of developments that add to transportation efficiency.

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POWER *Stands for . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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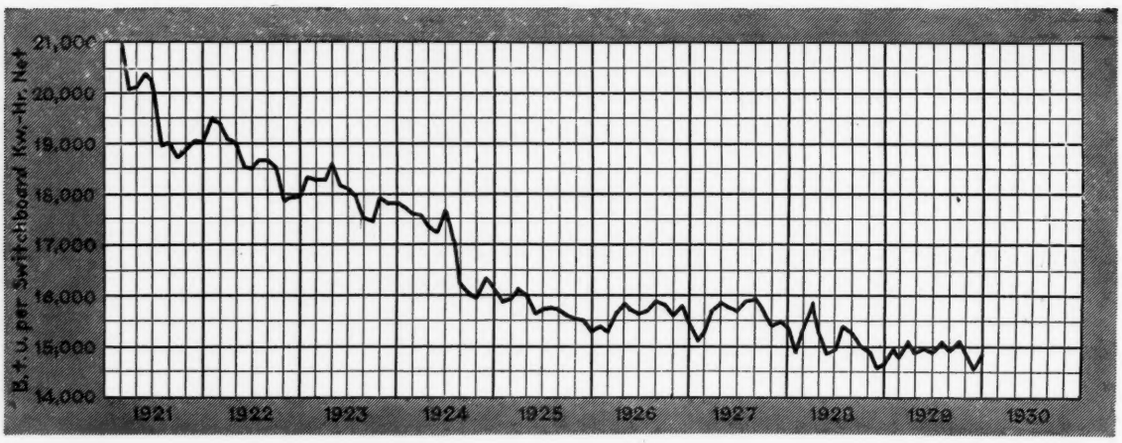

Nine years of steady improvement in economy at Lakeside

LAKESIDE'S SECOND HIGH-PRESSURE UNIT

By THOMAS WILSON
Associate Editor of Power

There is only four minutes' storage of water in the boiler drums and feed regulation is by hand. Feed water flow and steam flow are maintained coincident, and the water level is checked by means of a periscope. Flue gas mill drying improves boiler room efficiency and reduces investment.

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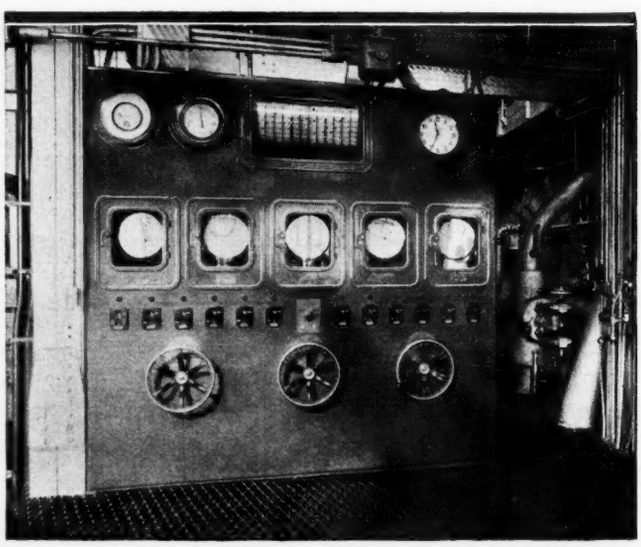
IN OCTOBER, 1929, the first 1,300-lb. boiler and turbine installation at Lakeside station[1] had been in service for three years. The boiler had operated 75 per cent of this period, and last year 85 per cent of the available hours, having completed during the year the third four-month continuous operating period. The high-pressure turbine availability during 1929 was 100 per cent. Operation was carried on for 16,000 hr. without internal cleaning of the boiler, and indications were that it could be operated indefinitely without turbining. Practically all interruption to continuous service had been occasioned by repairs to the radiant steam reheater functioning at 300-lb. pressure.

Operating continuously for a month at approximately 95 per cent load factor, which represented about 29 per cent of the station output, the high-pressure section improved the station economy by 1,000 B.t.u. per kilowatt-hour of output. This improvement in economy, considered equivalent to a saving of $7,500 per month, together with the highly satisfactory operating record of the 1,300-lb. section, induced the Milwaukee Electric Railway & Light Company to increase the high-pressure capacity of the plant. A 7,700-kw. turbine, virtually a duplicate of the first machine, was installed. It has now been in operation for some time at 1,250-lb. pressure. Boiler capacity was increased by adding a second high-pressure unit, varying in certain respects from the original boiler, and present plans call for the installation of two more similar turbine and boiler units next summer.

Use of a convection reheater between the two banks of boiler tubes instead of a radiant reheater on the rear furnace wall, adoption of flue gas mill drying and the location of the mills immediately in front of the boiler rather than in a separate preparation house are the



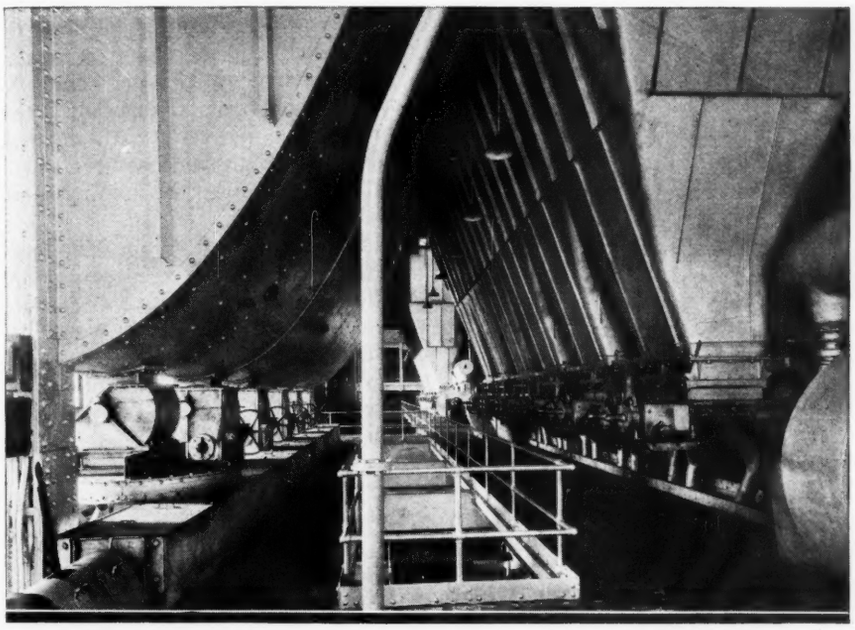
Boiler control center

[1]This, the first large central station built to use pulverized coal exclusively, went into operation in 1922.

essential differences of the second boiler installation from the original design.

Reference to the sectional elevation will show that the new boiler is of the three-drum bent-tube type, with the tube banks separated sufficiently to accommodate between them a convection reheater containing 8,600 sq.ft. of surface in 2-in. tubes. The reheater is made up of 106 elements each of 155-ft. combined length, formed by joining shorter tubes by welding. The boiler design permits 1,390 lb. maximum pressure and an operating pressure of 1,300 lb. Feed water is introduced at 360 deg. F. and the maximum steam output per hour is 300,000 pounds.

In the boiler alone are 23,640 sq.ft. of surface. The drums are of forged steel $5\frac{1}{4}$ in. thick, 40 in. inside diameter, and approximately 40 ft. long. There are 1,190 tubes, 70 wide, of 3-in. outside diameter, having a wall thickness of 0.35 inch.



Feeder deck of high-pressure boiler room at Lakeside: Raw coal bunker at left and pulverized fuel bins at right

From the rear steam drum two saturated-steam offtakes lead to the radiant superheaters forming the side walls of the furnace and containing in total 1,128 sq.ft. of surface in 212 two-inch tubes. In the previous boiler, superheater elements of $2\frac{1}{2}$-in. square cross-section had been used. Although operating performance was entirely satisfactory, weight and cost reduction considerations prompted the use of the 2-in. round elements with 0.3-in. walls in the second unit. The tubes are placed vertically on $2\frac{1}{2}$-in. centers and, to obtain nearly uniform metal temperatures, are arranged for four passes, so that the coldest steam enters at the burner end of the superheater, where the highest heat transfer rates occur.

Steam temperatures at the superheater outlet range from 730 to 790 deg. F., but can be modified by reducing the coal fed to the burners near the side walls. At full rating the pressure drop through these superheaters is less than 20 lb., a small amount for this pressure range and representing but a slight energy loss. The heat transfer has averaged 37,000 B.t.u. per sq.ft. per hour.

From the superheater the steam at 1,250-lb. pressure passes to the high-pressure turbine, is exhausted at a pressure of 310 lb. gage and a temperature of 450 deg. F., and is returned to the convection reheater, from which it is delivered at the initial temperature to the station 300-lb. header or directly to one of the 300-lb. turbines in the plant.

Experience with the first boiler unit had shown that radiant superheaters were more reliable at high pressures than at lower pressures. One reason for the use of radiant superheaters at higher pressures is disclosed through reference to total heat entropy charts, which show that the steam temperature lines between 700 and 800 deg. F. have a greater slope at 1,200 lb. than at 300 lb. Internal turbine temperatures are more nearly constant with radiant superheater characteristics. Higher density, greater specific heat, and more favorable viscosity of high-pressure steam all promote better heat transfer and lower metal temperatures. Stresses in the tube walls are higher, but metal temperature has greater influence than stress in causing creep and ultimate failure. In the present installation reheater outlet temperatures have averaged 790 deg. F. for six months without any indication of creep.

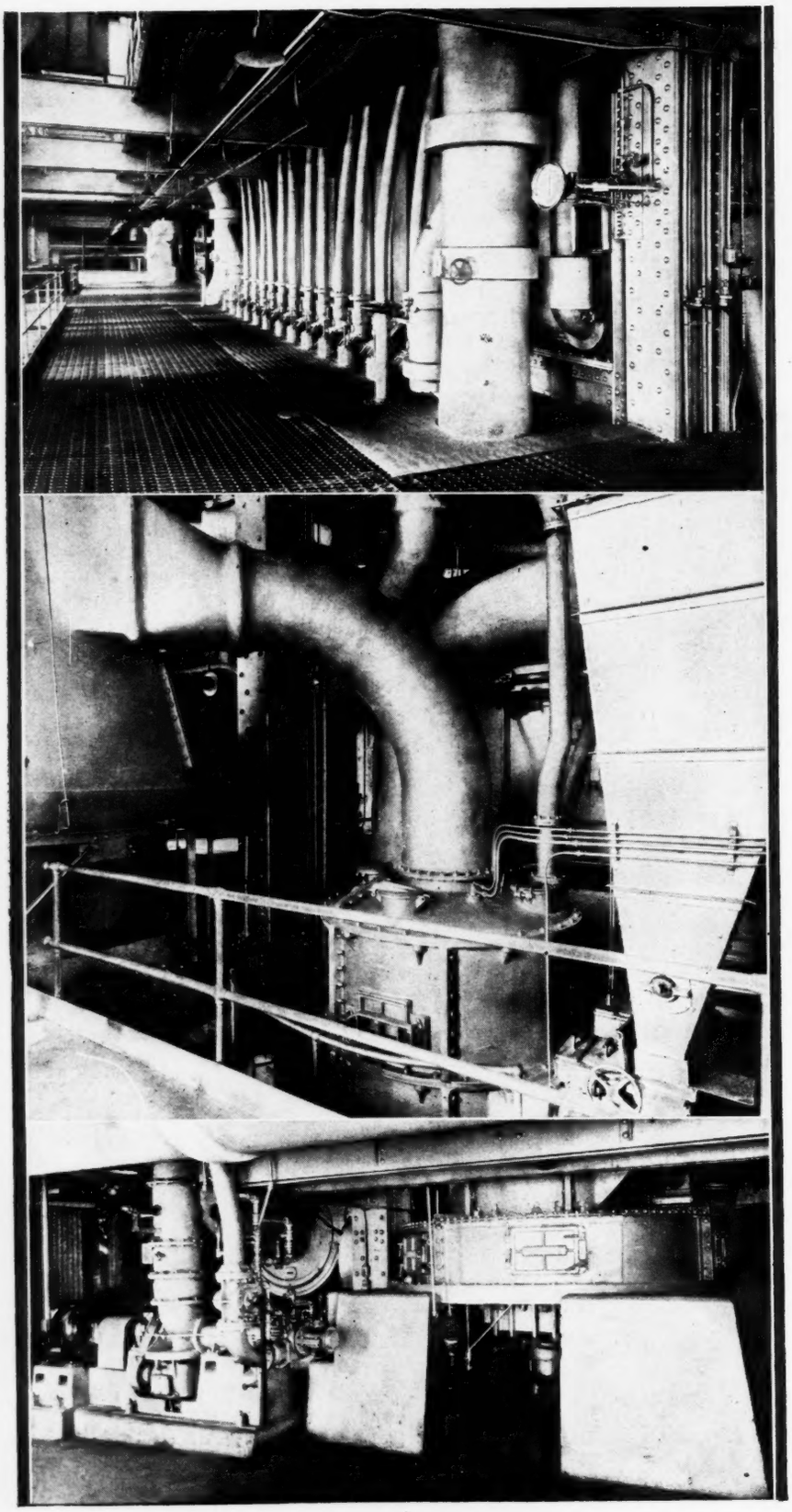
Using the combination of a radiant superheater and a convection reheater, with the high-pressure turbine operating in compound with one of the lower-pressure machines, results in remarkably uniform steam temperatures in both turbines over a wide range of load. The drooping characteristic of the radiant superheater with increase in load and the rising characteristic of the convection reheater, one opposing the other, form an ideal combination for steam temperature control and, as a result, for the maintenance of practically constant blading temperatures in the low-pressure turbine as well as in the high-pressure machine.

As has been stated, the superheaters form two sides of the furnace. The front and rear furnace walls and the arch are water cooled by means of 70 tubes at either wall connected into the boiler circulation, and a 66-tube water screen protects the furnace bottom. The header arrangement for these tubes may be seen in the sectional drawing of the boiler unit.

After making four passes over the heating surface, the gases flow down from the rear bank of tubes into a plate-type air heater, back of the furnace, containing 310 elements, 5x25-ft., and gross surface aggregating 77,500 sq.ft. The air spacing is $\frac{3}{8}$ in. and the gas spacing $\frac{1}{2}$ inch.

Fuel preparation and burning equipment consists of one 15-ton 6-roll mill and twelve feeders and burners per boiler. Owing to the fact that the original preparation plant, built in 1920, had been outgrown upon the installation of the second high-pressure boiler unit, and to the adoption of flue gas mill drying, the entire fuel preparation equipment, including the raw coal bunker, was placed immediately in front of the unit. For the sake of uniformity, as well as for improved economy, the same arrangement will be extended to the original high-pressure unit of this boiler house. In this way hot-gas, vented-gas and coal-transportation lines are shortened.

An accompanying diagram shows the layout of the system. About 6 per cent of the flue gases at a tem-



Top—Operating deck, giving access to the burners and control board. Center—One of the 15-ton 6-roll mills arranged for mill drying. Bottom—Base of mill; transport pump at left

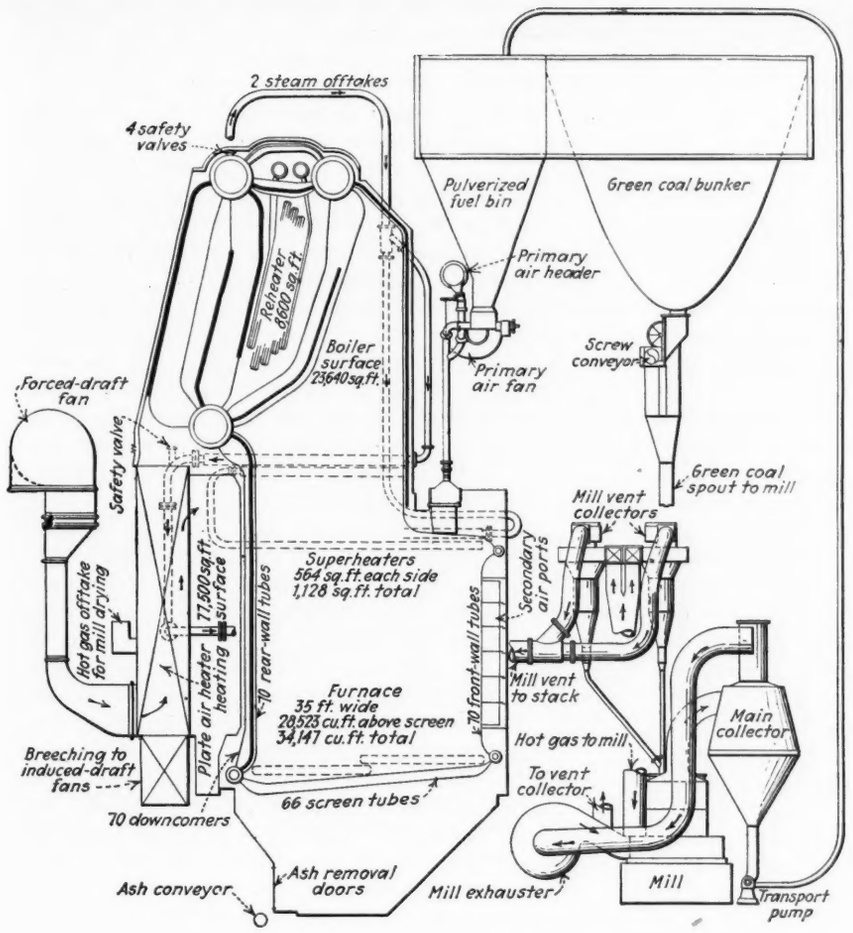
perature approximating 550 deg. F. and containing 15 per cent CO_2 are drawn off the air-heater casing and introduced into the mill circuit between the exhauster and the mill. In the mill system and collectors 12 per cent CO_2 is maintained, so that danger of fire or of an explosion from smoldering coal is materially lessened. After passing through the mill, the gas temperature is reduced to 150 deg., as compared to a temperature of 350 deg. at the air heater outlet. Computations have shown that this reduction in gas temperature, coupled with improved air-heater performance from the greater ratio of air flow to gas flow, actually increases the boiler room efficiency by 0.75 per cent. A moisture content of 5.5 per cent is reduced to 2.5 per cent. Anticipated trouble from corrosion has been obviated by insulating the piping and collectors.

Reference to the diagram will show that the vent fan has been placed on the clean side of the main collector to exhaust 25 per cent of the gases to the stack through auxiliary collectors that return to the top of the mills most of the fine coal carried in suspension in the vent gases. The coal loss in the vent is 0.25 per cent, so that the net credit from the drying process is 0.5 per cent.

In the regulation of these high-pressure boilers a primary factor is the assurance of maximum reliability. At full load there is only four minutes' storage of water in the boiler drums, so that the operator must know at all times how much water is entering the boiler without waiting for the level to vary. The load is practically constant for hours at a time, but with so short a time available to correct any mishap, constant vigilance is necessary.

The operator's station is on the operating platform in the vicinity of the control board, where steam pressure and steam flow, water level and feed-water flow may be visualized and adjustment made by means of the hand-operated feed-water control valve. The boiler pressure gage is mounted on the column and the sight tube of the periscope is below it.

No feed-water regulators are used. Instead, a recording feed-water flow meter mounted adjacent to the steam-flow meter gives information that reduces control effort to a minimum. The two records are kept continuously coincident. When the load changes, the feed rate is varied with the steam flow and the water level is inspected as a check.



Second high-pressure boiler unit and mill installation

To facilitate inspection of the water level, a full size image of the water glass is brought down to the operator by a specially designed periscope. The sight tube terminates immediately under the pressure gage. A similar contrivance was used with the first boiler. According to previous statements, the basic principle consists of using the water meniscus as a mirror. When illuminated from a point 90 deg. below the horizontal and viewed from an equal angle on the opposite side, the meniscus appears as a bright band of light against a dark background.

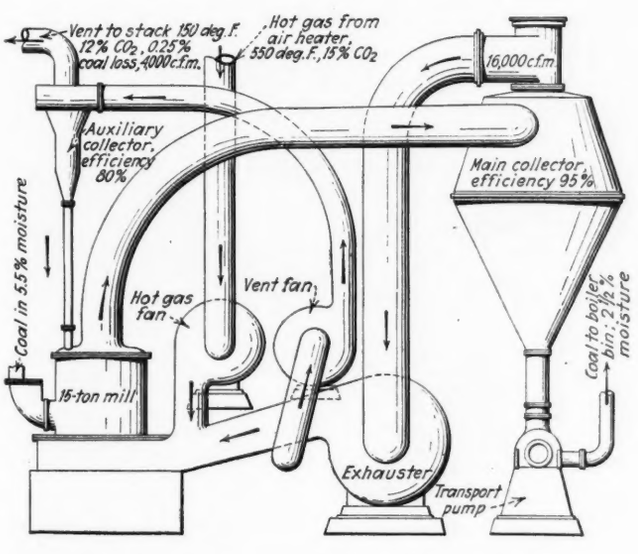

Vent to stack 150 deg. F. 12% CO_2, 0.25% coal loss, 4000 c.f.m.
Hot gas from air heater; 550 deg. F., 15% CO_2
16,000 c.f.m.
Auxiliary collector, efficiency 80%
Main collector, efficiency 95%
Coal in 5.5% moisture
Hot gas fan
Vent fan
Coal to boiler bin; 2½% moisture
15-ton mill
Exhauster
Transport pump

Diagram of flue-gas mill-drying system

By means of a system of inclosed mirrors, the gage glass appears upright in the sight tube, and the band of light designating the position of the meniscus contracts and distends with slight variations in water level. Powerful lamps illuminate the glasses. Without the mirrors a view of the water level from the operating deck, 28 ft. below, would have been impossible owing to interference from grating and other intervening equipment.

Lakeside's economy curve is of interest, as it shows the trend since 1920 has been downward and how in the later years the effect of the high-pressure units has manifested itself on the station's record. The curve is painted on the wall of the plant club room to keep before the men the importance of economy and the possibility of obtaining more bonus by bettering the efficiency.

Wasting 50,000,000 Kw.-Hr. Daily

THE wastage of natural gas incident to the rapid development of oil fields has been of appalling proportions. This waste, in California alone, rose as high as 850,000,000 cu.ft. daily in the latter part of 1929. When it is recalled that natural gas is very rich in energy (about 1,000 B.t.u. per cubic foot) and that one kilowatt-hour can easily be produced from 15 cu.ft. of gas, the loss can easily be evaluated in terms of electrical energy. During 1929 the total electrical energy generated by all the central stations of the United States, plus that imported, averaged about 250,000,000 kw.-hr. per day. Allowing 15 cu.ft. of natural gas per kilowatt-hour, the California maximum daily wastage of 850,000,000 cubic feet would produce 57,000,000 kw.-hr., or more than 20 per cent of the nation's total.

This does not imply, of course, that power generation should be the primary application of natural gas. A fuel of such high form value is naturally and properly applied first to domestic and specialized industrial uses.

It is to the credit of California that the seriousness of this waste of natural gas is appreciated and that long pipe lines now under construction to San Francisco and other industrial centers will provide useful outlets for this great natural resource.

The Condenser As a Heater

By R. K. Long

A CONDENSER is essentially a heater, or rather a heat extractor. Its effectiveness is dependent upon its ability to deliver water heated as near as possible to the temperature of the steam. The closer the temperature of the heated water to that of the condensed steam, the more efficient the condenser, although not necessarily the more economical to operate. Yet, how many engineers look upon their condensers as heaters?

To the average engineer, a condenser is something to create vacuum and its performance is viewed in terms of inches of mercury. Since inches of mercury is one way of expressing vacuum, it is well that the engineer should study his mercury column. On the other hand, would there not be a tendency to obtain higher over-all economy if the condenser were operated as a heater and the temperature differential between steam and water held closer? While the ideal turbine improves continuously down to the lowest condenser pressures, the actual turbine, as is well known, cannot make as good use of the last inch or two of vacuum as it can other parts of the expansion range. Expressed differently, the highest efficiency ratios occur in the moderate ranges of vacuum. Hence it becomes particularly important to know how efficiency changes with the vacuum and to what extent warm or cold circulating water permits an increase or decrease in the pumpage.

It has been said that vacuum is to condenser performance what carbon dioxide is to furnace performance. Each is the one single important index. Engineers know fairly well the significance of varying percentages of carbon dioxide, what it means when it goes down or up and what it represents in percentage of preventable waste. The same thing cannot be said, however, of vacuum, or to what extent a variation from the ultimate represents loss of fuel, decrease in capacity or preventable loss. Condensers of the same type follow the same general curve of vacuum-heat transfer. At the same time, each condenser has its own peculiarities, while other factors interfering with condenser operation are the condition and temperature of the cooling water, as well as oil and scale on the inside of the cooling surfaces due to dirty steam. How do these two conditions combine to lower the average vacuum? How do they vary during the different seasons of the year? To what extent should they modify the cleaning routine?

Knowing the maximum vacuum that can be utilized by the turbine is not nearly as important as knowing the maximum vacuum that is economically worth while. During the cold weather with low cooling-water temperatures, conditions are ideal to do a little experimenting upon the water rate and auxiliary power consumption, to find out what vacuum is the most economical at winter water temperatures. What is the most desirable velocity of the cooling water through the tubes; how does the rate of heat transfer vary with the water velocity and how does changing velocity affect over-all condenser efficiency? Surely this subject is worthy of as much thought as furnace operation, for condenser losses are additive to those of the coal pile.

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Pumps Suspended from Cables Used to Dewater Dam Site

PUMPS hung from cables stretched across a canyon were used by the General Construction Company of Seattle, Wash., to remove water from the site of the dam now being constructed at Owyhee, Ore., across the Malheur River. The project involves the construction of a structure to a height of approximately 250 ft., having a length at the crest of some 1,500 ft. and backing up the river for 52 miles.

Diversion of the river necessitated construction of a tunnel 25 ft. in diameter and 3,000 ft. long through solid rock. With this completed and the river diverted from its old channel, it was necessary to remove the water remaining at the dam site in order to begin construction of the dam foundations.

Two electrically operated deep-well pumps were used, each having six feet of column and direct connected to a 75-hp. induction motor. The pumps were suspended on cables stretched across the canyon, and were raised and lowered by means of a winch located on the platform where the pump was mounted. General Electric magnetic control was used to start and stop the pumps, push button stations being placed on the platform where the pump attendant was stationed. This made it unnecessary to mount heavy starting equipment on the platform, which had to be raised and lowered to meet the water conditions encountered.

The pump in the foreground is pumping out the hole and discharging into the river below the lower cofferdam. The other is sluicing earth and loose rock off the canyon walls.

Tracing the Ancestry of BOILER SAFETY DEVICES

By M. P. JARED

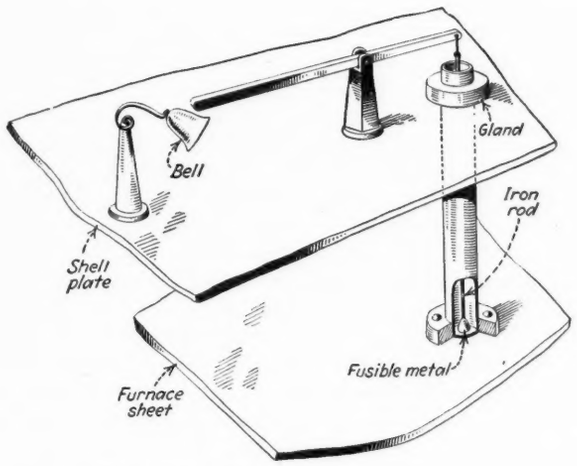


Fig. 1 — Bache's low-water alarm of 1832

EARLY in the development of the steam boiler the need of certain appliances to regulate its operation attracted the attention of engineers, and in 1695 the Papin safety valve was patented. This design was similar to the ball-and-lever valve in common use during the early part of the last century.

In 1800 Watt's deadweight safety valve was used, but was limited to low pressure boilers. The Stephenson spring-loaded safety valve was patented in 1833 and embodied some of the principles of the modern pop safety valve, although there was no blow-back ring and the spring was composed of a series of flat leaves.

So it appears that a proper safeguard from over-pressure was provided as soon as the use of the boiler progressed beyond the most primitive stage. However, a means of determining the level of the water within the boiler with any degree of accuracy did not command the interest of the engineers until the development of the steamboat and the locomotive.

In France and England the explosion of a number of boilers alarmed the public, while in America the explosion of the boilers on board the Mississippi River steamer Constitution in 1817 and those of the Herold, Amazon, Tally Ho, Porpoise, Grampus, Star, Caledonia and Helen McGregor upon the Western rivers, are recorded as having cost over 520 lives. The industries, principally the iron mills, were having similar accidents.

Frequently, the investigation of an explosion was superficial, although some were investigated thoroughly, with every available detail recorded.

Erasmus W. Burton, who had been the engineer in charge of the river steamer Enterprise was requested to report upon the results of his investigation of the explosion on the Constitution. He stated: "I was on board a few minutes after the explosion. From the appearance of the boiler it had been nearly dry and by forcing a quantity of water into it the head part of the boiler gave way and some 14 or 15 persons were blown into eternity by imprudence and neglect."

In reporting upon the explosion of a Boulton & Watts spherical top, or haystack, boiler, which was operated at the Ashton Forge near Birmingham, Engineer L. Herbert stated, "In this case it was ascertained that the explosion was caused by the boiler becoming red hot, into which the water was subsequently injected by the force of a pump, producing so instantaneous and powerful a volume of steam as to overcome the resistance of the vessel."

An engineer contractor, John S. Williams, in 1831 addressed a communication to the editor of the *Journal* of the Franklin Institute on the subject of lessening the accidents incidental to navigation by steam. In it he reviewed at considerable length the many conditions encountered in the operation of steamboat boilers, the unknown strength of various members of the structure, the dependability, or lack of it, of different materials, and mentioned available information pertaining to a number of boiler explosions. Williams concluded: "I am fully persuaded that metal overheated under high pressure is never again fit to bear pressure, either as a boiler or flue, and overheating of the boiler and flue should be guarded against; for overheating is very likely to generate a quantity of highly rarified steam to the destruction of the boiler and crew by a sudden explosion."

Jacob Perkins, an American engineer, who invented the steam gun in which he interested the British and French governments in 1827 and who in 1826 developed a steam boiler to carry 800 lb. pressure, did not consider the increase in normal steam pressure from the 10 lb. used as a maximum in the Watts boiler, to the 100 lb. used in the cylindrical boilers as being responsible for the great number of fatal boiler accidents. Perkins considered low water to be the only cause of violent explosions, and, as a remedy, suggested the plan of preventing the water

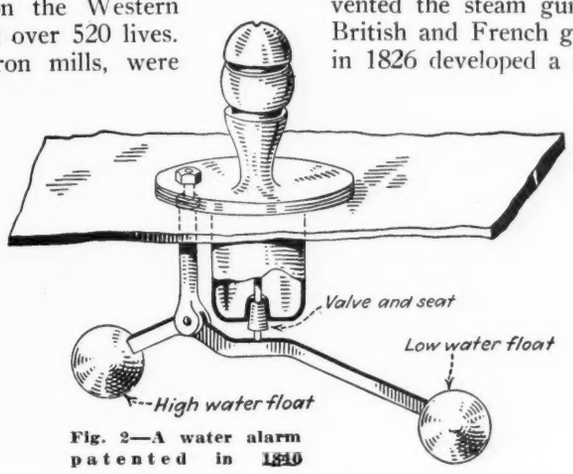


Fig. 2—A water alarm patented in 1840

from subsiding below any part exposed to the furnace fire.

Perkins also advanced the theory that a condition of low water caused the steam in contact with the overheated boiler surfaces to become highly elastic and of an increased temperature, capable of imparting those characteristics to the steam, which would be released from the water in case the safety valve should operate or other valves open. His conclusions were based upon the large number of accidents to boilers that had happened when the engines were started or when the safety valves opened.

Prof. Robert Hare of Pennsylvania University stated, "It has been suggested that some extraordinary evolution of the gaseous elements of water or even an inflammable

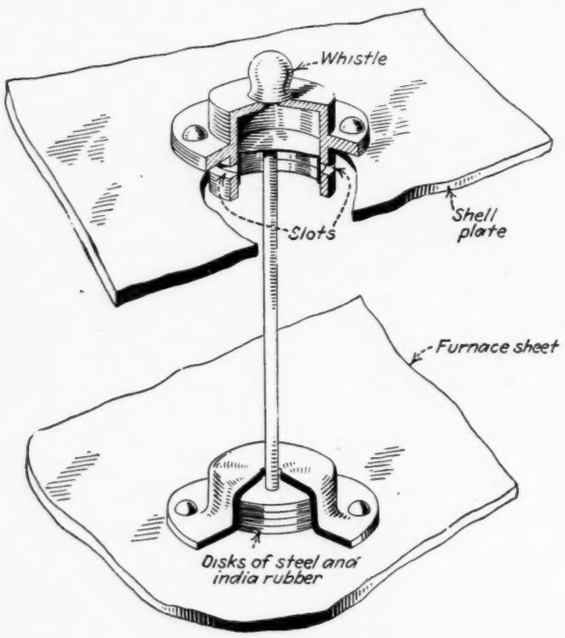


Fig. 3—The Parsons safety alarm of 1858

aqueous vapor may have contributed to the explosion of the boilers of the steamboat Aetna."

The French had encountered the same difficulties, and, following the same line of reasoning, M. Marestin, a skillful naval contractor, and M. Arago, listed as an engineer of mines, looked upon the lack of sufficient water as the root of the evil, but disagreed with each other as well as with Perkins as to the sequence of events and the influence a release of the pressure might have.

France had issued a decree in 1810 regulating the installation and operation of high-pressure steam boilers and engines "in which the elastic force of steam exceeds two atmospheres." Additional regulations were adopted in 1823. Article 4 of these regulations provided for two safety valves, each of sufficient capacity to discharge all of the steam generated by the boiler. One of the safety valves could be adjusted by the engineer, but the other was inclosed in a locked grating.

Article 5 stated: "There shall, in addition to these two valves, be adapted to the top of each boiler two metallic plates. The first metallic plate must be of an area at least equal to one of the safety valves, must be made of an alloy which shall melt or soften so much as to yield to pressure at 10 deg. C. (18 deg. F.) above the temperature corresponding to the proof mark (maximum safe pressure) upon the boiler. The second metallic plate must be of twice the area of the first, shall be placed near and inclosed in the same grating with the safety valve and shall be of an alloy which will fuse or soften at 20 deg. C. (36 deg. F.) above the proof mark upon the boiler."

Thus appeared the first legal requirement covering the use of a fusible plug, which, it will be noted, was of the low-temperature type and was composed of a mixture of lead, tin and bismuth in such proportions that an increase of temperature of 6 or 7 per cent attending an increase in pressure or extremely low water would cause the disk of alloy to soften and permit leakage even if complete fusion did not take place.

The fusible disk was $\frac{9}{16}$ in. thick and was reinforced by a mesh of iron or copper bars to prevent distortion at normal temperature. The alloy was prepared by the French mint and was stamped with the degree of temperature Centigrade at which it would fuse.

Of course, if the softening produced complete fusion, the failure of the disk was comparable to the opening of a safety valve without the advantage of automatic closing when a slight decrease in pressure had been effected.

The British House of Commons recognized the effect boiler explosions were having on the public interest in transportation so in 1817 appointed a committee on the subject.

In 1827 Congress proposed an act regulating steam vessels, but it was the bill of 1836 on the subject that showed more clearly the result of the theory of low-water explosion, as also did the bill that became a law in 1868, although the Committee on Boiler Explosions appointed by the Franklin Institute had reported in 1836: "It appears from these experiments that the gas obtained by injecting water upon the bottom of a boiler which was at a bright red heat was nitrogen gas, with a variable quantity of oxygen. It was in fact atmospheric air de-

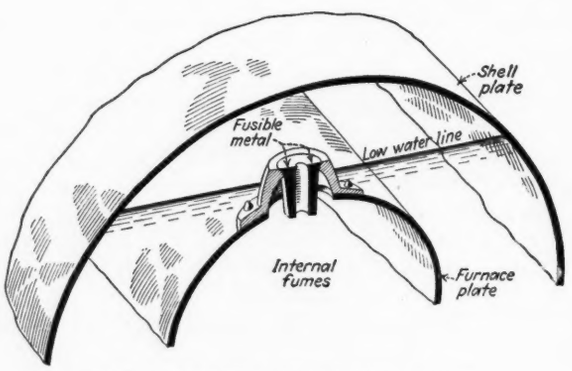


Fig. 4—Cowburn's fusible plug of 1867

prived by the highly heated metal of more or less of its oxygen. The experimental boiler was small, but the amount of air it contained was great in proportion to the amount of water injected at each test, so it would not be possible to have a perceptible amount of air with the steam in an operating boiler."

In those days the bag of sand or other additional weight upon the lever of the safety valve of a steamboat boiler was sufficient to quiet that troublesome appliance when the river's bank seemed to travel in the wrong direction. The alloy fusible disk was intended to terminate this practice, as well as to keep the engineer on the alert lest the water be evaporated more rapidly than its delivery by the supply pump. However, the ingenuity of the engineer was equal to the occasion, as it is recorded that in case the water were found to be low or if an increase in pressure were desired the safety valves were overloaded and a stream of cold water was poured

upon the fusible disks to keep their temperature from reaching the plastic point.

The glass water gage tube was mentioned as an experiment as early as 1825, but, due to the difficulty of tempering the glass tube, the flat glass gage was first to attain popularity. The gage cock, which was taking on its present appearance, was the most dependable gage, although the dial indicator was in common use. Difficulty with the gland through which passed the rod connecting the dial indicator with the internal float led many engineers to prefer the cock.

In 1832 Prof. A. S. Bache, who later was appointed chairman of the Franklin Institute's "Committee to Investigate Boiler Explosions," developed a low-water indicator, illustrated in Fig. 1, consisting of a tube extending from the top of the boiler to a flue or to the internal furnace. The lower end of the tube was closed, and threaded into a flange riveted to the wall of the flue or furnace and contained the metal plug of fusible alloy. To this plug was secured a rod leading through the open upper end of the tube to a lever, and held that lever balanced in a horizontal position.

In case of low water, the fusible metal became plastic and released the rod, allowing the unbalanced lever to strike a bell, thus warning the attendant of the state of affairs. When the increased supply of water cooled the furnace, the fusible alloy solidified and retained the rod, which had dropped to its original position, so that the lever was again horizontal, ready to strike the alarm bell when again permitted to descend.

The boiler alarm safety valve illustrated in Fig. 2 was patented in 1840. This device, through the use of two floats, sounded a whistle for low water and for high water. It appears to be the ancestor of the high- and low-water column in current use.

The low-water-alarm float was arranged to start the feed pump, as well as to turn a stream of water upon the fuel bed, in case of low water. Each device met earnest advocates, as well as those who would not buy at any price.

The Parsons' "safety alarm valve" shown in Fig. 3 was patented in 1858. The boiler shell was provided with a hood having holes closed with a piston held in position by a rod upon the lower end of which was secured a series of steel disks alternating with disks of india rubber. This combination of steel and india rubber piston was encased in a housing riveted to the boiler flue or furnace.

A deficiency of water would cause the india rubber disks to heat and soften, in which event the piston at the upper end of the rod would descend, permitting steam to escape through the holes into the hood. The escaping steam, and possibly the odor of the burning india rubber, would arouse the engineer, so the inventor claimed.

In 1867 Cowburn patented an "alarm fusible plug," shown in Fig. 4, which may be said to be more directly related to the appliance required by some legal authorities today. The Cowburn plug was limited in application to internally fired boilers of the Scotch marine and similar types.

An opening cut in the crown of the internal furnace was closed with a cap carrying two tubes each containing a plug composed of "grain tin" with a fusing temperature of 442 deg. F. This device differed from its predecessors in two specific particulars. The fusible metal was not a low-temperature alloy, but pure tin having a fusing temperature above the temperature of steam at the pressures then in use.

Fusing of the metal discharged steam from the boiler through the empty tubes into the furnace and retarded combustion, just as a steam jet is now frequently used to extinguish fires, particularly in the cotton industries.

The modern fusible plug of the A.S.M.E. Boiler Code, Fig. 5, was developed and patented by the National Boiler Insurance Company of England. The fusible metal is 99 per cent pure tin and is inserted in the boiler plate at the lowest permissible water level, with the small end of the tin plug exposed to the products of combustion.

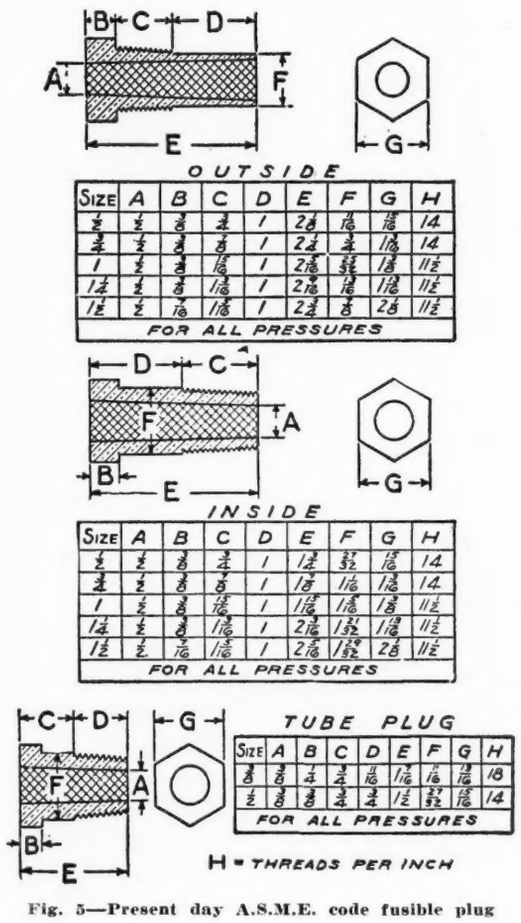
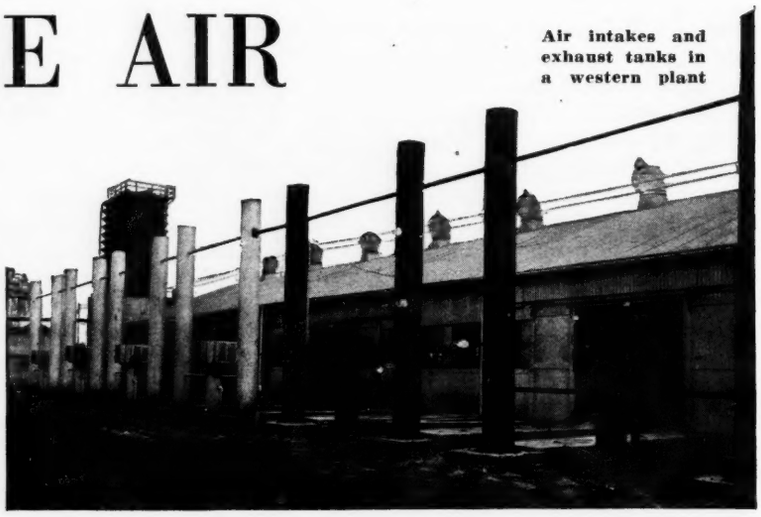


Fig. 5—Present day A.S.M.E. code fusible plug

Locating Reducing Valves to Insure Efficient Operation

MOST reducing valves require installation in a vertical position and have an arrow cast on the valve body showing the direction in which the steam should flow. To obtain the best results the valve should be installed in the highest point of the steam line to reduce trouble caused by entrained water and dirt. It should be located so that the bonnets and working parts of the valve can be removed without having to break the pipe joints. When a reducing valve is in use the inlet valve should be fully opened. No reducing valve is absolutely reliable for any definite length of time, and a relief valve must be fitted on the outlet side to insure protection against damage by excessive steam pressure.—*Bulletin of Engineering Information,* United States Navy.

DUST-FREE AIR *for Diesel Engines*



Air intakes and exhaust tanks in a western plant

By L. A. PEASE
Assistant Director of Engineering, Fairbanks, Morse & Co.

If clean air is used in the Diesel cylinder, piston and liner wear is reduced to a marked extent. It follows that as the replacement of these parts constitutes two of the larger items in the maintenance account, no plant can afford to introduce dirty air into a cylinder.

WHILE THE amount of dust in what is popularily called "clean air" is about 0.10 grain of dust per 1,000 cu.ft., a slight wind may raise this to 5 grains. Even quiet air near the street level may contain 1½ to 2 grains, and in places such as quarries the content may reach as high as 10 grains per 1,000 cu.ft. of air. Startling as it may seem, a 100-hp. Diesel may draw in as much as 400 lb. of dirt in a year's operation unless a screen or filter is used.

Air for an engine may be from either within or outside of the building. When taken from the engine room, a rapid change of air occurs in the room and arrangements must be made to bring the air into the room through some form of duct in the wall or the roof. Neglect to provide for this air flow has in some instances resulted in a room pressure below that outside and the engine did not obtain its needed air change.

It is preferable in most cases to take the air directly from the outside, especially in winter months.

The duct that carries the air from the outside of the building should be of such size that pressure loss through the line at full engine capacity does not exceed ½ in. of water in a crankcase scavenging engine, or 2 in. in a two-stroke-cycle engine with scavenging pumps or in a four-cycle unit. The volume drawn into the working cylinder is the suction-stroke piston displacement. This is

$$\frac{0.7854\ D^2 \times L \times N}{1{,}728}$$

where D is the piston diameter in inches, L the length of stroke in inches, N the number of power strokes per minute of the unit, and 1,728 the factor converting cubic inches into cubic feet. For single-acting, one-cylinder, two-stroke-cycle engines the number of power strokes is the same as the revolutions, and for four-stroke-cycle single-acting, single-cylinder engines it is one-half the r.p.m., since it has a combustion period at every other revolution.

For double-acting single-cylinder engines the quantity is twice the amount needed by a single-acting engine of the same bore and stroke. To find the amount needed by an engine of several cylinders, that found for the single-cylinder, is, of course, multiplied by the number of cylinders.

An example will show the amount of air required. Suppose it is desired to figure a duct for a six-cylinder, two-stroke-cycle, 14x17-in., single-acting, 257-r.p.m. crankcase Diesel. Substituting in the formula,

$$\frac{6 \times 0.7854 \times 14 \times 14 \times 17 \times 257}{1{,}728} = 2{,}338 \text{ c.f.m.}$$

The standard duct for this size of engine has a diameter of 18 in. The velocity of air through the duct will then be

$$\frac{2{,}538}{\text{Area of duct}} = \frac{2{,}538}{1.77} =$$

1,430 ft. per minute, ignoring correction factors.

From Table I, giving the friction losses in pipes for air at 60 deg. F., it is seen that an air velocity of 1,500 ft. per minute uniform flow

TABLE I—FRICTION LOSS IN PIPES FOR AIR AT ATMOSPHERIC PRESSURE AND 60 DEG. F.

(Loss in ounces per square inch per 100 ft. of pipe.)

Velocity of Air, Ft. per Min.	Diameter of Pipe or Duct, In.						
	12	14	16	18	20	22	24
500	0.023	0.020	0.017	0.015	0.014	0.013	0.011
1,000	0.092	0.080	0.069	0.062	0.056	0.051	0.046
1,500	0.206	0.180	0.156	0.139	0.125	0.113	0.104
2,000	0.365	0.322	0.278	0.248	0.222	0.201	0.185
2,500	0.575	0.500	0.435	0.385	0.348	0.315	0.290
3,000	0.833	0.714	6.625	0.555	0.500	0.455	0.417
3,500	1.110	0.970	6.850	0.759	0.680	0.620	0.568
4,000	1.480	1.280	1.115	0.990	0.890	0.810	0.740
4,500	1.860	1.710	1.410	1.250	1.125	1.020	0.940
5,000	2.300	2.000	1.740	1.540	1.390	1.310	1.160

1 oz. per square inch = 1.732 in. of water.
1 in. of water = 0.577 oz. per square inch.

through an 18-in. pipe has a pressure loss of 0.139 oz. per 100 ft., which is equivalent to $0.139 \times 1.73 = 0.24$ in. of water.

Although an 0.24-in. pressure loss seems small, the total loss may be several times this amount on account of the pulsating flow to the several cylinders and because of the presence of elbows. It is possible that resonance may be set up, increasing this loss materially. Therefore the limit of 0.5 in. loss for a crankcase engine may be easily reached in a duct 40 ft. long with one elbow in it. One should see that the air line to the engine is not smaller than that recommended by the manufacturers and is free as possible from elbows.

When a Diesel plant is located in a residence district, where noise is objectionable, it is usually necessary for the customer to install a silencer on the air inlet. When air is taken into a pipe without silencing, entrance

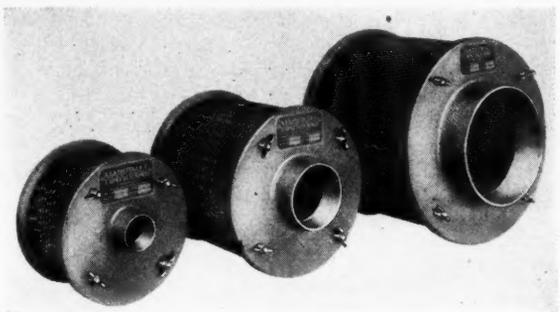


Fig. 1—A dry-type filter for small engines

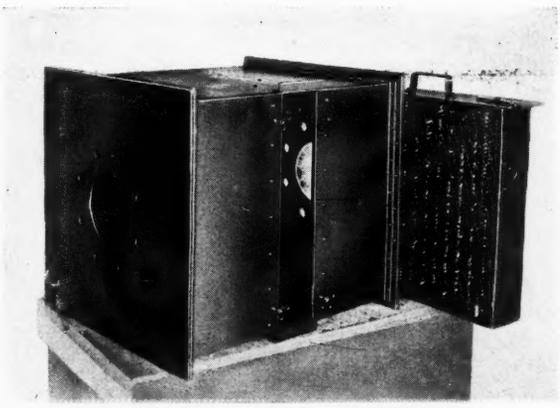


Fig. 2—The wet-type catches the dirt on oil-coated screens

velocity, and the noise, varies greatly. In silencing, the air passages are so arranged that air enters the opening of the silencer at a much slower velocity and passes through at increasing speed until it reaches the engine inlet point.

The intake may also be silenced with a Maxim silencer, which reduces the noise by reducing the air velocity. Slotting the intake pipe, or installing a lattice silencer are other means employed. Air enters the latter at the bottom of the outer case and passes through the lattice cylinder before reaching the engine duct.

With the air silencer on the inlet and an air filter in the line, the operator is assured of a clean air supply for the engine, and at the same time there will be no disturbance due to the engine drawing air for combustion.

The ducts are usually made of galvanized iron or vitrified tile or concrete covered with some coating to prevent concrete dust from getting into the air supply.

A simple and economical arrangement consists of a duct connected to a vertical housing outside of the engine room wall, with a screen and cover at the top. The in-

TABLE II—RESISTANCE OF 90 ELBOWS

Radius of Throat of Elbow in Diam. of Pipe	No. of Diameters of Straight Pipe Having Equivalent Resistance
¼	67
½	30
¾	16
1	10
1¼	7.5
1½	6
1¾	5
2	4.3
2½	4.5
3	5.0
4	5.2
4½	5.5
5	5.8
5½	6.0

take opening may also be equipped with louvres to keep out the rain, if it is desired to keep the roof confined to a small overhang. Arrangements are made to have a hinged damper in the line so that all or a part of the air can be taken from the engine room. This is advantageous in both winter and summer, as the movement of air in the engine room can be controlled.

Three types of air cleaners are in general use. In the centrifugal, or dry type, Fig. 1, the air passes over baffles and the change in direction throws out the dirt, which settles into a chamber. This is not in general use for Diesel plants, but it is common on portable gasoline engines. It is quite economical and effective.

The moist type, shown in Fig. 2, consists of a steel framework, approximately 20x20 in. and 3½ in. thick, with a steel perforated sheet on one side and a wire screen on the other. The filtering medium may be a cup-shaped metal punching or a material resembling steel wool. These sections are dipped in a liquid solution which remains in a sticky state, collecting the dirt from the air as it passes through the filter. After the filter has collected an amount of dirt that raises the pressure drop through the air system by about ½ in. of water, the elements are taken out, washed in soda and redipped in the solution. It is customary to have one spare unit so that replacement can be done without shutting down the engine.

For very large Diesel plants the filtering equipment usually consists of woven-wire panels arranged to revolve continuously over a horizontal shaft, with the lower end of the screen dipping into a cleaning solution. They are constructed in capacities up to 50,000 cu.ft. of air per minute and are suitable for the largest installation.

Fig. 3—Filters used at Ponca, Okla., Diesel plant

Locating FAULTS in FIELD COILS

By M. A. WALKER
Cleveland, Ohio

Taking voltmeter readings across field coils to locate short circuits

Troubles likely to develop in field coils are grounds, open circuits and short circuits. The effects of these are explained and how to make tests to locate the defects is shown.

AFTER the polarity of the field coils in direct-current machines is correct the troubles that may develop in them are grounds, short circuits and open circuits. The effects that any of these faults may produce will depend upon the conditions under which they occur. For example, a ground in one field coil of a machine the frame of which is insulated from ground will have no effect upon operation. This is also true for a machine that is operating on an insulated system. To produce an objectionable effect the ground must occur under conditions that will form a complete circuit. This would happen on a machine with its frame grounded and connected to a power system that is grounded. Most 240-volt direct-current systems are three-wire, with the neutral grounded. If the frame of a machine on such a system is grounded and a ground occurs in one of the field coils it will cause trouble.

Assume that the motor in Fig. 1 is connected to a two-wire system that has the — side of the line grounded. If a ground occurred in field coil F_1, part of this coil and the others would be cut out of circuit. The circuit would be from the + side of the line through the starting box into coil F_1 to the frame of the machine and through the earth to the ground on the — side of the system, back to the generator. If the ground occurred in field coil F_2, part of this coil and coils F_3 and F_4 would be cut out of circuit. The nearer the fault is to the F_1 terminal of the machine the less its effect will be. That is, if F_1 and A_1 terminals were grounded it would not affect the machine's operation, provided they are connected to the grounded side of the line.

With a ground in F_1 coil, this coil and the no-voltage release coil on the starting box would become excessively hot and their insulation would be destroyed in a short time. A ground in F_2 coil would cause coils F_1, F_2 and the no-voltage release coil to overheat, and the other two field coils would remain cool.

What happens on a three-wire system with the neutral grounded when a ground occurs in the field coils is different from what occurs in a two-wire system. A ground on F_2 coil in Fig. 1 will not completely short circuit coils F_3 and F_4 out of circuit. Consideration of Fig. 2 will show what takes place. The three-wire system is assumed to be obtained from two generators in series. With the field coil free from grounds the 240 volts are divided across these coils in proportion to their resistance. If the field coils have equal resistance the voltage will divide equally across them, or each coil will have 60 volts impressed on its terminals. Two coils in series will have $2 \times 60 = 120$ volts across their terminals, so that the point between F_2 and F_3 coils will be at the same potential as the neutral. If this point were grounded it would have no effect on the operation of the machine.

With a ground in F_2 coil, as indicated in Fig. 2, the neutral point in the coils is shifted from between coils F_2 and F_3 into coil F_2. Under this condition there is 120 volts impressed from the D terminal of F_1 coil to the ground in F_2 coil, and consequently the voltage and the current increase across this part of the circuit. There will be 120 volts from terminal C of F_4 coil to the ground in coil F_2, and the voltage and current will decrease on this section of the circuit. The difference between the current in the two sections of the circuit flows from the ground in coil F_2 back through the neutral to generator B. The closer the ground is to terminal D the more current generator B will have to supply. A ground on terminal D would cause a short circuit of that machine.

With a ground in F_3 coil, as in Fig. 3, there will be 120 volts across coil F_4 and part of coil F_3; that is, the ground will cause the voltage to increase across this part of the field circuit. This would also cause an increase in the current in this part of the circuit and a decrease in voltage and current between terminal D and the ground in coil F_3. The difference between the currents in the two parts of the circuit is supplied from generator A through the ground, as indicated by the arrowheads. The nearer the ground in the field coils is to terminal C the greater is the current that will be supplied by generator A. A ground on terminal C would cause a short circuit of that generator.

Grounds in the field coils can be located by the usual lamp test. If the frame of the machine is grounded and the system grounded, locate the side of the switch that will light a lamp to ground. Then connect the lamp to this side of the switch and to the field coils, as in Fig. 4. If the lamp does not light, try testing to the machine's frame, where the lamp should light if everything is correct to make the test. If the lamp lights when touched to the frame of the machine and does not when connected to the field-coil terminals, the coils are free of grounds.

When the frame of the machine is insulated the test is

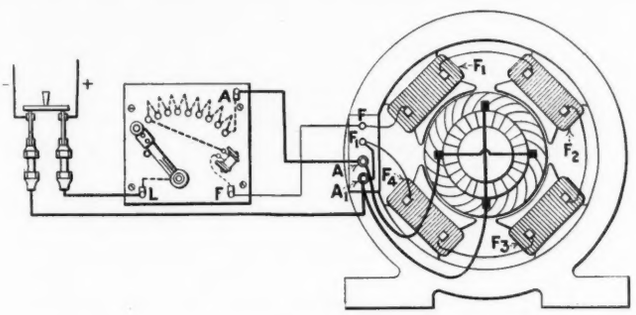


Fig. 1—Diagram of shunt motor connected to a manual-type starting box

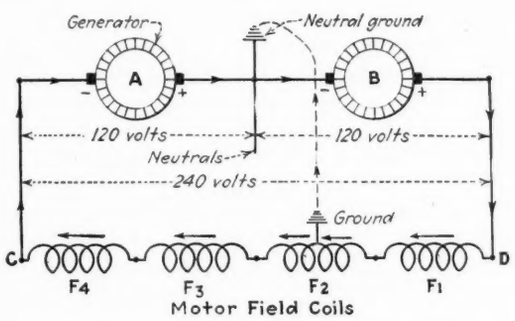


Fig. 2—Diagram showing effect of a ground in coil F_2

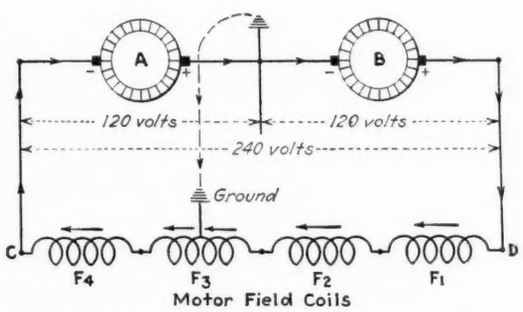


Fig. 3—Diagram showing effect of a ground in coil F_3

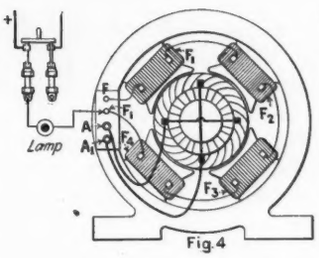


Fig. 4

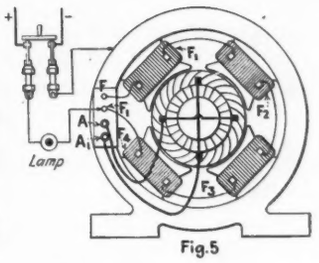


Fig. 5

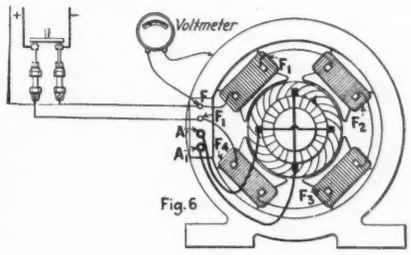


Fig. 6

Figs. 4 to 6—Methods of testing field coils for grounds

made for grounds in the field coils as in Fig. 5. The lamp lighting indicates a ground in the coils and the absence of a light shows that they are insulated. The faulty coil can be located by opening the connections between the coils and testing them separately. First, open the connection to divide the coils in two equal groups and test each group separately. This will show which group the fault is in and this group can again be divided and tested until the faulty coil is located.

Where the field coils can be connected to the line for testing, as on an insulated system, a voltmeter may be used to locate the faulty coil directly, as in Fig. 6. The voltmeter is connected from one of the field-coil terminals to the frame. If there is a ground in the coils the voltmeter will read the voltages from the terminal to where the fault is. For instance, in the figure, assume that the coils are connected to a 240-volt circuit and the voltmeter, when connected as shown, gives a reading of 160 volts. Since the four coils are in series across 240 volts, each coil should have 60 volts across it. Then the fault is $160 \div 60 = 2\frac{2}{3}$ coils away from terminal F, or in F_3. The faulty coil can be disconnected and tested to make sure that a mistake has not been made in the voltmeter test.

Grounds in the series or commutating-field coils will cause a short circuit and open the protective equipment if the frame of the machine and system is grounded. Ground faults in these coils, if they cannot be detected by inspection, may be located by a lamp test as explained in Figs. 4 and 5.

Open circuits in field coils is another common fault. An open in the shunt field coils may cause the motor to race if lightly loaded, or the protective devices will open. With the fault in the series- or the commutating-field coils, the motor will not start. These faults in a generator will prevent the machine from coming up to voltage. If a motor is giving trouble, a test can be made for an open in the shunt-field coils by opening the armature circuit at the starter and then bringing the starter on the first point, as in Fig. 7. If the field circuit is closed, when the starter is allowed to drop to the off position an arc will occur at the contact when the circuit is broken. The absence of the spark shows that the field circuit is open.

The fault may be in the wiring or in the coils. With the starter close on the first point, a lamp connected as at B, Fig. 7, will show whether the fault is in the starter. If the lamp lights it indicates that the field circuit is com-

pleted through the starter. When the field circuit is complete to the motor a lamp will light when connected across the field terminals as at *C*. An open in the coils is found by connecting one lead from the test lamp to one of the terminals of the field coils and testing between the coils with the other lamp lead, as at *D*.

Assume that the fault is in coil F_2: when the lamp is connected between coils F_2 and F_3 it will light, for the faulty coil is out of circuit. When connected between coils F_1 and F_2 the lamp will not light, showing that the defective coil is in circuit. If a lamp is not available the coils may be short-circuited by a piece of wire, as at *E*. When the defective coil is bridged, a spark will be obtained when the wire breaks contact with the coil's terminals.

Short circuits constitute a third fault that may develop in shunt field coils. A short circuit in a coil cuts part or all of it out of circuit, and as a result the temperature of the defective coil will be lower than the others. In the case of a two-pole machine a complete short circuit of one coil will probably cause the other coil to burn out if it is left in service very long. If a field coil is found burned out, it is pretty good evidence that other coils in the group are short-circuited.

A case in point is that of a two-pole machine in which one of the field coils roasted out. The coil was rewound

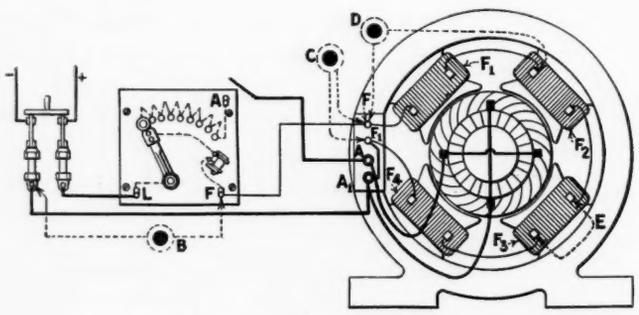


Fig. 7—Testing for open circuits in field coils

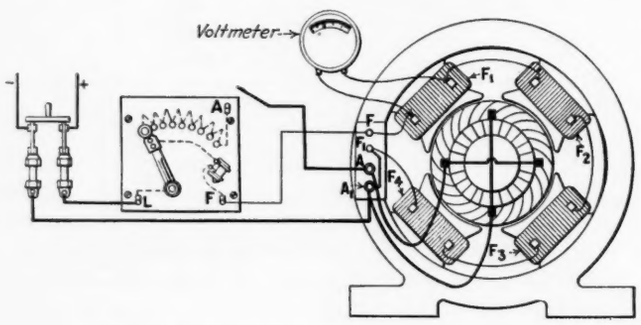


Fig. 8—Testing for short circuits in field coils

and the machine put into service without giving any attention to what caused the trouble. Shortly afterward the rewound coil roasted out and was replaced, only to fail a third time. An investigation then showed that the apparently good coil was short-circuited. A test of this coil should have been made when the first failure occurred. It would have revealed where the trouble was.

A test for short circuits is made on shunt-field coils by connecting them to the line and measuring the voltage across each coil with a voltmeter. If the coils are in good condition the voltage readings obtained across them should be equal. On a 240-volt four-pole machine the voltage across each coil should be $240 \div 4 = 60$ volts. If a coil is short-circuited, its reading will be less than 60 and that across the others will be more. Were one coil completely short-circuited, the voltmeter connected to its terminals would indicate zero and the other three coils would give a reading of $240 \div 3 = 80$ volts.

To make the test, assume a motor connected to a manual-type starting box, as in Fig. 8. The armature

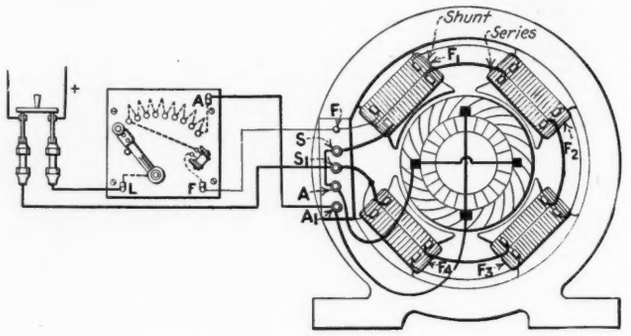


Fig. 9—Diagram of compound motor connected to manual-type starting box

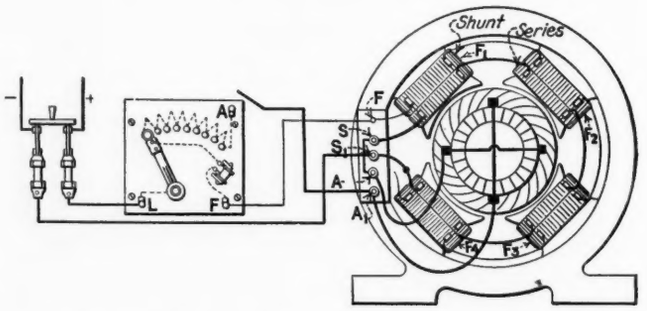


Fig. 10—Testing compound motor for short circuit between shunt and series coils

circuit is opened as in the figure and the arm of the starting box is placed on the first point. With a voltmeter take readings on the terminals of each coil. A few volts' difference in the readings need not be considered serious, as this can be due to a variation in the number of turns in the field coils if they were not carefully wound. A difference of 15 or 20 volts is sufficient to indicate that all is not well in the low-reading coil and the cause should be investigated.

Another field-coil fault is a short circuit between the shunt and series coils in a compound machine. The effect is to cut part of the shunt coils out of circuit. For example, in Fig. 9 a short circuit between the F_2 shunt coil and its adjacent series coil would cut part of the F_2 coil and coils F_3 and F_4 out of circuit. This would cause serious heating of F_1 and F_2 coils. The armature would also heat, due to circulating currents in its windings, and the brushes would spark badly if the machine were anywhere nearly loaded. A test can be made for this fault by opening the armature at the starting box, as in Fig. 10, and opening the connection between the shunt and series windings at the machine. Both the armature and field circuits are now apparently open. When the arm on the starter is brought on to the first point and allowed to drop back, there should be no arc when the contact is broken. The presence on an arc shows that a circuit is complete between the series and the shunt coils. This fault rarely develops in machines that have the two coils wound separately, as in the figure. The fault is most likely to occur in small machines where the two coils are taped together.

Conserving WASTE HEAT *for* BUILDING WARMING

Heat given off by machines, electric lights, boiler settings and electric generators can be used to supplement the building heating system. This article shows the magnitude of these heat wastes and how they may be conserved

By CHARLES L. HUBBARD

IN ALMOST all large buildings, but particularly in industrial establishments, there are large quantities of waste heat liberated. Knowledge of what these wastes will be by the engineer who is designing the heating system for such buildings can be used to advantage in reducing the size and therefore the cost of many installations.

It is not always possible, however, to predict for just what purpose a building will be used, and in such circumstances the heating system must be designed to provide the necessary heat without consideration of the waste heat that may be liberated in the building. Utilization of this heat then becomes an operating problem to a large extent or changes must be made to meet particular cases. Any salvaging of heat that would otherwise be lost ultimately reflects in the fuel bill, and should therefore be carefully looked into to see what can be saved as a profit.

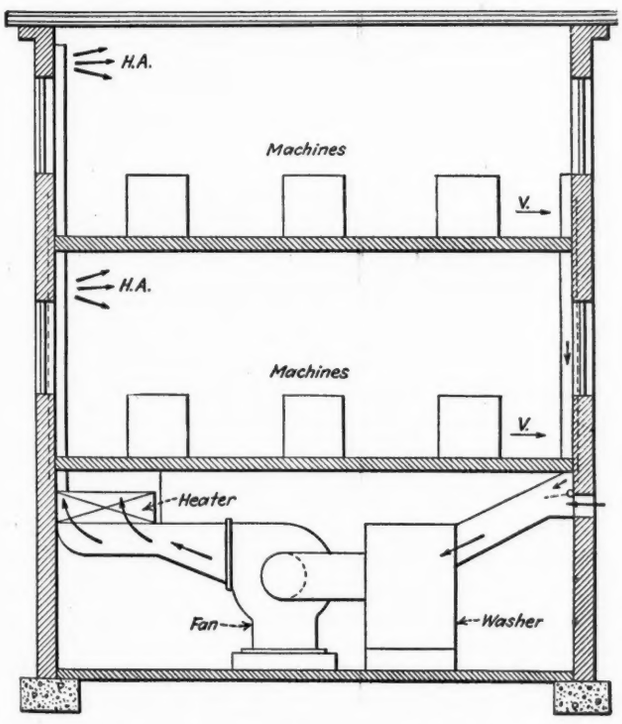


Fig. 1—A system such as this utilizes the heat given off by machines

Many of the various sources of heat are commonly overlooked and their magnitude little realized.

The human body, for example, is a combined furnace and machine. Food taken into the system goes through practically the same chemical action as fuel burned in a furnace, and therefore gives out heat in much the same way. Considered as a furnace, an adult at rest will emit approximately 400 B.t.u. per hour. This is of special importance in a theater or assembly hall.

In a theater seating 3,000 people the heat given off from the audience will amount to $3{,}000 \times 400 = 1{,}200{,}000$ B.t.u. per hour. A heating boiler having an efficiency of 65 per cent, using coal with a heat value of 13,000 B.t.u. per pound, will utilize $13{,}000 \times 0.65 = 8{,}450$ B.t.u. per pound, from which it is evident that the bodily heat given off per hour by the audience is equivalent to that produced by burning $1{,}200{,}000 \div 8{,}250 = 142$ lb. of coal in the boiler furnace, and will amount to about $3 \times 142 = 426$ lb. during an evening show, or $6 \times 426 = 2{,}556$ lb. per week.

Considered as a machine, man does work and produces heat in the process. At rest, he gives out 400 B.t.u. per hour, but when engaged in average labor this is increased to 518 B.t.u. in a room temperature of 68 deg., and to 575 B.t.u. per hour for hard labor. In the case of a factory room having 100 operators engaged in average labor, the heat given off would be $518 \times 100 = 51{,}800$ B.t.u. per hour, or $51{,}800 \times 8 \times 210 = 87{,}024{,}000$ B.t.u. for eight hours per day for a heating season of 210 days, which is equivalent to $87{,}024{,}000 \div 8{,}450 = 10{,}300$ pounds, or 5.2 tons of coal burned in the boiler furnace. The saving in coal in either case is a comparatively small item, but this is only one among other sources of supplementary heat that make up a total of considerable importance.

Another example of a supplementary heat is that given off by electric lights. The heat from this source in B.t.u. per hour, equals watts $\times$ 3.413. Assuming 12 sq.ft. of floor space per person in a theater, and 2 watts per square foot of space, the energy consumed for lighting amounts to $3{,}000 \times 12 \times 2 = 72{,}000$ watts, which will give out $72{,}000 \times 3.413 = 245{,}800$ B.t.u. per hour. The lights in a theater, however, are in use for only a com-

paratively short time, but this might well be an important item in an audience hall for other purposes, or in a suite of large city offices where artificial light is depended upon to a considerable extent. In the average factory building the total hours of lighting do not reach a large figure, but the item of heat is of considerable importance when the lights are on, and may help out the heating system an appreciable amount.

An important source of heat in many manufacturing plants is that produced by friction in power-transmitting equipment and in the working of machines. When power is transmitted to machinery from outside, the heat in B.t.u. per hour is equal to the brake horsepower delivered × 2,546; this factor being the B.t.u. equivalent of one horsepower-hour. When electric drive is employed,

$$\text{the B.t.u. given up per hour} = \frac{\textit{Motor horsepower}}{\textit{Motor efficiency}} \times 2{,}546.$$

Suppose in the factory room previously mentioned that each operator tends a machine consuming, on an average, 1.5 hp., in which case the heat given off per hour will equal 100 × 1.5 × 2,546 = 381,900 B.t.u. This, added to the body heat, will amount to 381,900 + 51,800 = 433,700 B.t.u. per hour, or 433,700 × 8 × 210 = 728,616,000 B.t.u. for the heating season, which is equivalent to $\frac{728{,}616{,}000}{8{,}450 \times 2{,}000} = 43$ tons of coal. This is for a single room, and in a large plant would amount to a substantial figure.

Some time ago a large milling concern in the West arranged to utilize the heat from the grinding machines for warming the buildings, and planned on saving some 300 tons of coal per year by doing this. The examples given are chiefly to show the methods of computing the heat from these different sources rather than the actual amounts, which will, of course, vary with local conditions.

Older ideas on ventilation considered it necessary to take all air for the supply fan from outside, and discharge from the building an equal amount of warm air. This was done because this air was supposed to be harmful due to lack of oxygen, the presence of carbon dioxide and other poisonous substances given off in the process of respiration. Modern ideas consider temperature and humidity control, and air motion the important factors, so it is possible to utilize the heat given off from these supplementary sources by drawing off the warm air and returning it to the building, there to be mixed with a small amount of outside air (20 to 30 per cent) to maintain a degree of freshness. If processes carried on in the building produce dust or odors, the recirculated air should be passed through a washer.

A method sometimes employed in cases of this kind is shown diagrammatically in Fig. 1. When the building is warmed by direct radiation, the body and friction heat is given off to the air in the room and relieves the radiation of an equal amount of work. To obtain the full benefit of this for reduced fuel consumption it is necessary to employ automatic temperature control, or other means of close regulation, so that the rooms may not become overheated and the windows opened.

While the saving in fuel may be an important factor in this connection, the possibility of reducing the radiating surface may sometimes exceed it.

For example, in the room previously considered the total heat available from supplementary sources was 433,700 B.t.u. per hour, which is equivalent to that given off by 433,700 ÷ 240 = 1,800 sq.ft. of direct radiation.

It is necessary, of course, to provide sufficient heating surface to warm the building to the normal temperature of 68 deg. before the operators arrive or the machinery is started. Thus when heating is done by direct radiation there is little opportunity to reduce the surface installed. If outside air is supplied for ventilating purposes, it is possible to use the heater provided for tempering this air during the warming-up period, when ventilation is not required. This works out particularly well in theaters and assembly halls, where ventilation and air movement are important factors and the major part of the heating is done by a steam coil in connection with the fan. Here the full power of the heater may be used for warming up the auditorium; then after the audience assembles the temperature of the air supply may be reduced to 68 or 70 deg. for ventilation only and the entire warming be done by bodily heat. Under these conditions the size of the main heater may often be reduced from 30 to 40 per cent, depending upon various local conditions.

Where a manufacturing plant employs electric drive and provides its own electricity, the generator will furnish a considerable amount of heat, which sometimes can be utilized to advantage. As the efficiency of a generator commonly runs from 95 to 98 per cent, it is evident

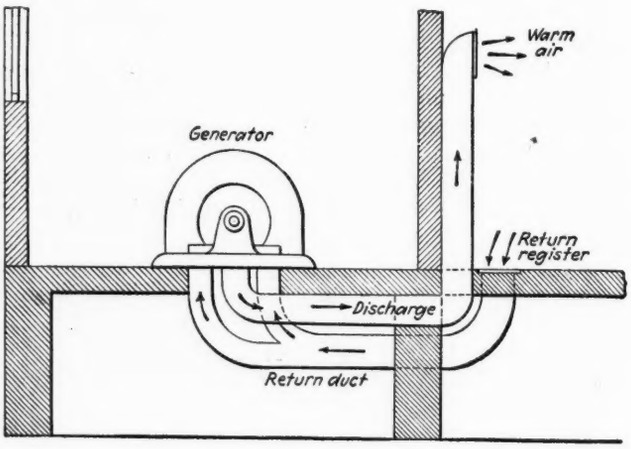


Fig. 2—Utilizing heat from generator to warm near-by room

that from 2 to 5 kw. out of each 100 kw. produced will appear in the form of heat energy.

For example, a 1,000-kw. generator having an efficiency of 96.5 per cent will transform 1,000 — 965 = 35 kw. into heat energy, which is equivalent to 35 × 3,415 = 119,525 B.t.u. per hour, or 119,525 × 8 × 210 = 200,802,000 B.t.u. per heating season. This amount of heat supplied by the boiler would require

$$\frac{200{,}802{,}000}{8{,}450 \times 2{,}000} = 12 \text{ tons of coal.}$$

Looked at another way, if this heat is utilized it may be made to replace 119,525 ÷ 240 = 498 sq.ft. of direct radiation.

In the case of three-phase generators the quantity of heat produced will be increased by an increase in load, a decrease in power factor, or phase unbalancing, which causes induction currents within the windings of the machine. As this heat must be disposed of to prevent damage to the insulation, a study should be made to see whether it can be usefully employed either for warming

the buildings, or heating water, as conditions may indicate.

When cooling of the generator only is considered, it is customary to allow from 80 to 100 cu.ft. of air per minute per kilowatt loss. That is, if 90 cu.ft. is taken as an average, a 1,000-kw. machine having an efficiency of 96.5 per cent will require $1{,}000 \times 0.035 \times 90 = 3{,}150$ cu.ft. of air per minute for cooling purposes.

The allowable outlet temperature of the ventilating air

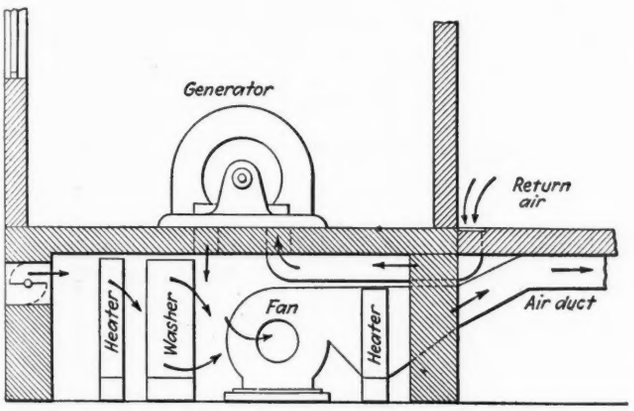


Fig. 3—Combining generator ventilators with main heating system

is fixed by the insulating material, and may be taken as 150 deg. F. for such materials as mica, asbestos and others having similar resistance to heat.

When the cooling air is used for heating or ventilating purposes after passing through the generator, the final temperature may be any lower figure best adapted to conditions, and the volume proportioned to carry off the required amount of heat for the assumed working temperature range. Suppose, in the above case, where 119,525 B.t.u. per hour must be removed, it were desired to return air to the generator from the building at a minimum temperature of 60 deg. and deliver it for heating and ventilating purposes at 100 deg.: what volume

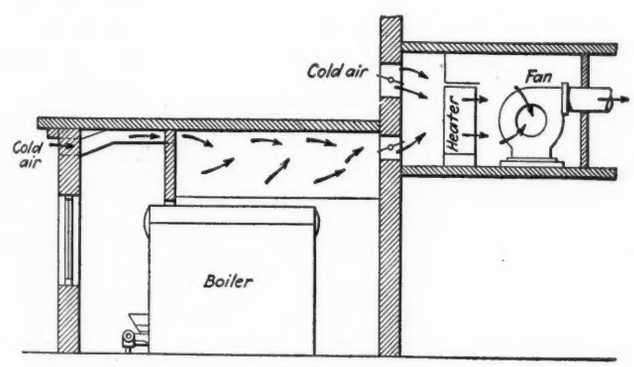


Fig. 4—Utilizing the heat radiated from the boiler settings

of air would be required to transmit this quantity of heat?

Here the working range is $100 - 60 = 40$ deg., and in raising the temperature of 1 cu.ft. this amount $\frac{1 \times 40}{55} = 0.727$ B.t.u. is required. Therefore, under the assumed conditions, it will be necessary to circulate $119{,}525 \div 0.727 = 164{,}000$ cu.ft. of air per hour, or 2,740 per minute.

There are two different ways of passing the air through the generator, one employing a separate fan and the other incorporating the fan in the generator construction. In the latter case the fan is proportioned simply for the cooling requirements and the frictional resistance of the machine. This arrangement may often be used for warming purposes, if the hot air has only to be carried a short distance at low velocity to a near-by room. If, on the other hand, a larger volume of air at a lower temperature is desired, or it must be carried for some distance through distributing ducts, a separate fan should be provided, designed specially for this service.

Fig. 2 shows an arrangement of the first kind where the air is simply recirculated through an adjoining room under a low frictional resistance. For larger volumes of air, and where it is to be carried for some distance through ducts, the layout in Fig. 3 may be employed, in which a special fan, washer and supplementary heater are used.

The generator in this case supplies only a part of the heated air. Other arrangements will suggest themselves according to various existing conditions in a plant under consideration.

Another source of supplementary heat, which may often be used to advantage, is the boiler setting. Ordinarily, this heat is disposed of through roof monitors or other forms of ventilators, and so goes to waste.

By inclosing the space over the boilers, as in Fig. 4, and drawing air through it, either from outside or from the boiler and engine rooms, this heat may be saved and used to supplement the general heating and ventilating system, as indicated in the figure, and at the same time to keep the power house at a more comfortable temperature. The exact arrangement that can be employed to best advantage will vary in different cases, but the general method shown in Fig. 4 can be used as a basis and modified as conditions may require.

Lithium, Lightest Solid, Purifies Metals

LITHIUM, the metal, is the lightest known solid. It is only a little more than half as heavy as water: light enough to float on ether or the lightest gasoline.

The pure metal is very unstable in the air and causes water to decompose at ordinary temperatures. When heated to just above its melting point, 365 deg. F., lithium burns with a dazzling white flame. Its salts, however, color flames a brilliant cherry red.

The metal has most remarkable chemical activity of a type to make it useful as a "scavenger" in purifying metals. It is said to be able to remove carbon, sulphur, phosphorus, oxygen, nitrogen and other impurities from alloys and pure metals. A few hundredths of a per cent of lithium, added to aluminum or its alloys, is said to produce a degree of hardness not otherwise obtainable. Such an alloy is "Skleron." A small fraction of a per cent of lithium added to lead makes a suitable bearing metal. This is the "Bahnmetall" extensively used on German railways.

A fair-sized use for lithium salts is in the Edison storage battery, where a valuable service is performed in increasing the electrical capacity of the cells.

INDUSTRIAL POWER

Some Economic Fundamentals

By P. W. SWAIN
Associate Editor of Power

What are the economic fundamentals that determine the kind of plant to build, when to buy power, when to revamp an old plant, what pressure to carry? Mr. Swain's answer, here reproduced in part, was presented to the New Haven, Conn., section of the A.S.M.E. on March 18

AS COMMONLY EXPRESSED, the objective of the industrial power engineer is "the delivery to the industrial plant, whether by purchase, by local generation, or by a combination of these two, of the desired power in the most satisfactory manner, and at the lowest cost." This statement, however, is a bit muddy and requires elucidation. In the first place, "power" must be defined more broadly than is usually the case. The various power services are so inter-related that any attempt to consider each as a separate problem must necessarily fail. We should therefore substitute for the single word "power" the phrase, "the entire group of power services."

The rest would be easy were it not for the phrase, "in the most satisfactory manner." Quality means, first, reliability, the maintenance of service at all times; second, the maintenance of desired voltages, frequencies, pressures and temperatures. We must naturally stop somewhere short of perfection in all of these matters, and just how short must depend upon the third factor, which is cost.

That is, strictly speaking, we are not looking for the best possible service at the lowest possible cost, but for that *degree* of perfection which will represent the best economy, balancing the additional cost of greater perfection against its money value.

This balance of quality of service against cost brings in what is perhaps the most fundamental economic idea in all engineering. It is one expression of the law of diminishing returns, and may be stated thus: "Increasing expenditures bring increasing operating returns, but at a steadily decreasing rate. In every case a point will eventually be reached where a further increase in expenditure will add fixed charges overbalancing the additional operating saving. That is the economic limit—the place to stop."

This law can be applied to the size of the pipe, the thickness of pipe covering, the efficiencies of turbines,

"Strictly speaking, we are not looking for the best possible service at the lowest cost, but for that degree of perfection which will represent the best economy, balancing cost against value."

the installation of spare units for breakdown service, and innumerable other things. In some applications the saving is easily evaluated, as in the case of pipe covering. In others, as in the case of spare units, one must attempt to express in dollars and cents such intangibles as the probability of a breakdown occurring, its probable duration, and the probable money loss entailed. This, necessarily, is scientific guesswork.

Even with known factors the application of this law is difficult where many elements are involved. One may, for example, be studying the economic effect of increasing the steam pressure in steps. A single step may involve changes in boiler and superheater design, piping changes and the introduction of economizers or air heaters. One must therefore work out for each pressure the most economical combination before making the final comparison between various pressures.

For example (see accompanying diagram) suppose we are comparing 200 lb., 300 lb. and 400 lb. and that for each of these pressures there are four combinations of equipment worth considering. It is seen that *C* is best for 200 lb., *G* for 300 lb. and *J* for 400 lb. and that, of these three, *G* is best. Therefore, quality of service being equal, 300 lb. is selected. The theory is simple, but the practical application is slow.

What I have said so far adds nothing to common engineering opinion. I now come to an engineering fundamental which I have never seen expressed, but which seems to me essential to clear thinking and sound decisions. It is this: "When, by any manufacturing process, two or more separate products are necessarily produced, it is impossible, fundamentally, to say which is a byproduct or to figure the individual costs of either or any of the products."

This statement may appear rather startling, and many may be inclined, at first, to disagree with it. However, I think I can make my point clear by some illustrations.

You are running a saw mill, let us say. Its products are lumber and sawdust. Your product, you insist, is lumber, and your byproduct sawdust. That seems quite reasonable as long as people will pay for lumber and will pay nothing for sawdust. Your cost problem,

too, seems quite simple. Your lumber cost is merely your total cost, and your sawdust costs nothing. Yet costs are supposed to be determined by what happens inside of your plant, and not by what people feel about your product after it goes out.

If by some strange cataclysm, lumber should cease to have any market value and sawdust became a highly valuable commodity, you would find yourself in the business of manufacturing sawdust. Lumber, if its production could not be avoided when producing sawdust, would become a valueless byproduct. Then one would insist that the cost of making sawdust was the total cost of operation and that lumber cost nothing to produce. Actually, you cannot tell what it costs to produce lumber or sawdust, you merely know the combined cost and assign it arbitrarily to one or the other as you see fit.

Clear thinking on this point is essential when considering the matter of so-called byproduct power, and it is necessary here to make certain assumptions determined by the situation.

At the start we can all agree on one thing, namely, that the combined cost of doing everything that has to be done should be kept as low as possible. If, under certain conditions, the assumption that a specific product is a byproduct will help the engineer to act in a way that will cause the greatest reduction in total expense, that assumption justifies itself practically. This is the justification, under usual conditions, of calling the power generated from process steam a byproduct or a partial byproduct. But such designation is not always justified even as a psychological prop, and in the future we may expect an increasing number of cases where it will be seriously misleading.

To see how this works out, consider a number of situations.

First, take the usual case where outside electricity is available and may be purchased or not, as desired, but where no outside steam is available. It is granted that the plant must generate steam for process and heating. The only choice lies in the generation of electricity. All of the electrical energy required may be generated locally. All of it may be purchased, or part may be purchased and part generated locally.

Regardless of how you define byproduct power, the proper solution, in this or any other case, is obtained by setting down the various possible combinations and seeing which gives the lowest combined net cost. That is, if you wish to compare purchased and generated power, for a factory you plan to build, you design or outline two complete plants, one a simple steam plant and the other a steam power plant. For each you figure the total yearly cost—interest, depreciation, labor, fuel, repairs, insurance, taxes, etc. In the case of purchased power you add the expected billing for electricity used. Reliability and other factors being equal, you choose, of the two, the one giving the lowest total.

For a complete solution you would have to consider the various plausible intermediate combinations, such as generating in winter and buying in summer, or buying a portion of the peak load and generating the rest.

"When by any manufacturing process, two or more separate products are necessarily produced, it is impossible, fundamentally, to say which is a byproduct or to figure the individual cost of either."

Where power can be generated from process steam the practical excuse for calling it a byproduct is that steam would have to be generated anyway, and that the additional generation of power generally requires only a slight additional consumption of fuel and a small additional investment.

The tables might, however, conceivably be turned. Imagine a strange community in which district steam is available at every plant, but no central station exists to furnish electricity. Every factory is then forced to generate its own electricity, but may or may not buy steam.

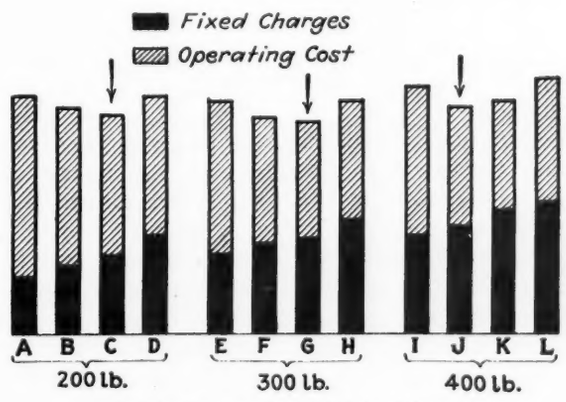
One plant may decide to put in condensing turbines to cut down the fuel required to generate the required power, and then purchase all steam for heating and process. Another may decide to burn considerably more fuel in supplying steam to back-pressure turbines, exhausting to process. In this case the "byproduct" would be the steam, and the "product" the power.

Still a third plant might decide to generate part or all of its power by passing the purchased steam through turbines before delivering it to process. Here again power becomes the "byproduct."

I do not mean to imply that the term "byproduct" is correctly used in these cases, but merely that it may be a convenient legal fiction.

Now take the case which is becoming increasingly common, particularly for great hotels, office buildings, department stores and public buildings in large cities. Both district steam and electricity from the outside are available, and the time has arrived to stop talking about a byproduct, since the term can only be confusing. Yet the problem here, as always, is to obtain all the power needed, plus all the process and heating steam needed, plus all other power services, at the lowest possible cost.

We now come to another common misconception: An existing plant, because of increased load, or because it is inefficient or nearly worn out, is faced with the alternatives of throwing out the present plant and buying all power; of maintaining the present plant and buying some power; or of revamping and enlarging the existing plant with or without the purchase of some power. It would ordinarily be said that, granting equal service and reliability in all cases, the proper move is the one that provides the additional power service demands for the smallest additional total cost. This much is easy — but what is the additional cost? At this point many engineers go astray. Nowhere is there



Illustrating method of determining the most economical steam pressure for a given set of conditions

more confusion. Usually, the first impression is: "Is the plant written off," or "Is the investment in the plant written off?" To my way of thinking, the answer to this question has nothing whatever to do with the problem. In my opinion, it makes no difference whether the plant cost a million dollars or ten cents, whether it has run 2 per cent of its pre-determined life or lasted twice as long as was figured. Depreciation and obsolescence as charged on the books are nothing but legal fiction—an attempt to distribute the first cost evenly over the estimated life of the plant.

When the plant was installed somebody made a guess that in ten years or fifteen years it wouldn't be worth

"Usually the first question asked is this: Is the investment in the plant written off? To my way of thinking, the answer to this question has nothing whatever to do with the problem of new investment."

keeping. If that guess was wrong—and it usually is—why allow it to spoil future engineering decisions.

In the past you have incurred certain debts, or you have not. You have paid them off, or you have not. Nothing you can do about a new plant will have any effect on that. Nothing you can do will have any effect whatever upon the results of your past fortune or misfortune in paying far more or far less, for the plant than it was worth.

If the accounting department charged off the plant long before it was worn out, or if it has not half finished the job when the plant is ready to be junked, that, again, has nothing whatever to do with the decision as to what should be installed. The only things worth considering are, what have you now actually, and what will be the future effect of things you may do now. The past is dead. Forget it.

With what actual present conditions and future possibilities are you confronted?

First you have a plant running. More steam and power capacity is needed. The boilers are good for five years more. The engines would last twenty. Perhaps your fuel consumption is high and your total operating expenses are above normal.

It is evident that something must be done now, and that a major change must be made not later than five years hence. The possibilities will include purchased power now or later, or part purchase now and complete purchase within five years. Still another will be part purchase now and complete local generation five years hence with a plant partly or wholly new.

In studying the contemplated investments in a situation like this they should be divided into two classes: First those that will have to be junked with the old boilers, and, second, those that can be carried on for 10 or 15 years more. The former must carry much higher fixed charges, based on a five-year life. Adding up all fixed charges in these two classes with operating costs for each set-up one can choose the combination that will give the lowest total yearly cost. You will note that no attention is paid to interest and depreciation on past investments.

There is a possible joker here if the plan adopted will leave one's hands tied in the selection of an economical plant at the end of five years. This is too long a story to go into, but we must use more foresight than the man who built a boat in the cellar and then had to tear the house down to get it out.

There is not time here to go further into this complicated matter of revamping old plants. Let us turn, therefore, to the case where the existing plant is so obsolete and wasteful that it will obviously pay to junk it completely and start over again. There are many such plants.

The engineer confronted with such a problem is fortunate, or foresighted, if he has provided himself with daily curves of actual steam and power demands for the various seasons. With these in hand he should proceed as follows: First he will study process loads to cut wasteful consumption and pressures at the point of use. Then, making allowances for future changes over the life of the plant, he will plot corrected curves for the consumption of power steam at various pressures.

The next step is to design or outline a series of plants each of which will take care of the projected steam load by exhaust or bled steam, by steam direct from boilers or by some combinations. Some of these set-ups will assume all power to be purchased. Others will allow for making of various portions of the power load up to complete local generation.

This onerous task completed, it will be a simple problem to select the plant giving the lowest total cost.

It is a matter of juggling prices and operating costs to determine whether it is better, on the one hand, to increase the proportion of byproduct power by higher steam pressures or more efficient units, or, on the other, to get more power from condensing units or by purchase.

The recent high-pressure trend in the process industries has resulted from a desire to take advantage of the very great possible increase in byproduct power. Where such power is needed the large industrial plant has much more to gain from high pressures than has the central station.

I would not have this interpreted as a recommendation that all industrial plants jump to 1,200 or 1,400 lb., fol-

"If the accounting department charged off the plant long before it was worn out, or if it hasn't half finished the job when the plant is ready to be junked . . . forget it; the past is dead."

lowing the recent central station trend. In the first place, without an outlet for excess power, there is nothing to be gained from higher pressure beyond the point where the power demand can be generated from the existing process steam load. Secondly, the additional cost of higher pressure to take care of occasional power peaks may not pay. It may be cheaper to care for these peaks by condensing operation or by purchased power. An occasional taxi ride may be cheaper than owning a second car.

Before adopting them the industrial plant must be willing to engage a personnel comparable in quality with that of the best central stations. Finally the water problem likewise must be carefully considered.

. . . RIGHT OUT OF THE PLANT . . .

Regrinding High-Pressure Cocks on Diesel Engines

WHEN operating a Diesel engine of the air-injection type, it frequently happens that one or more of the blowdown cocks start leaking, owing to wear or erosion from the escaping of high-pressure air.

The method of repairing these valves that has given the best results is simple but effective. The cock is taken apart and reground with a fine grade of compound. The compound is put on the plug part and the plug inserted in the body and rotated back and forth. At each half turn the plug is pulled out about one-half its length, then pushed in again, at the same time being given a rotating motion. This prevents grooves from forming.

When a grinding compound begins to get dry, put a little gasoline on the plug and it will take hold again. Pumice stone mixed with oil should be used for finishing. This will put a polish on the plug and insure a more perfect fit. I have used this method on 1,300-lb. pressure cocks and have had no trouble after they were put back into service.

One of the most common causes of failures on cocks of this type results from turning them in alternate directions instead of always in the same direction. When a cock starts to leak, one usually tries to stop it by drawing the plug tighter into the body, which generally causes it to cut in and does more harm than good. I suggest turning all cocks in one direction only and never attempting to tighten them to prevent leaks, but remove and grind them in properly. If this is done no more trouble is likely to be had for some time. ART WILLIAMS.

Kimball, S. D.

Can a CO_2 Record Indicate a Cracked Baffle

UNDER the title "Can a CO_2 Record Indicate a Cracked Baffle?" in the March 11 number is stated: "The best way to detect a broken baffle, then, is with a thermometer or temperature recorder in the stack or breeching."

Perhaps—but with certain types of firing equipment such a short circuiting of gases in the boiler may increase the furnace draft to the extent that the excess air induced will lower the exit-gas temperature considerably. In fact, uptake temperatures are affected so greatly by the amount of excess air that without draft gages the temperature indicator or recorder is far from sufficient in itself.

It is my opinion that a two-reading draft gage showing both furnace and uptake drafts tells the truest story concerning the condition of boiler passes.

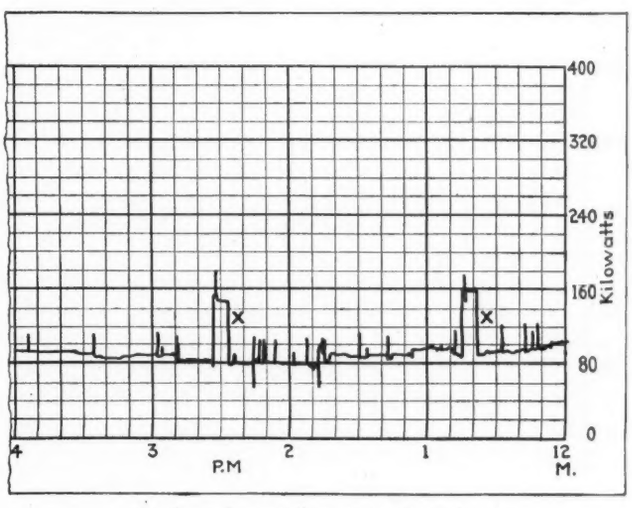
The relative position of the two draft indications pictures the differential or draft loss through the boiler (best shown by two pointers on a common scale.) A short circuiting of gases through faulty baffling decreases the differential and is shown by the two pointers being relatively close together. Conversely, a restriction of passes through fouling causes greater resistance and more differential, as shown by two pointers being farther apart than normally.

Thus is the draft gage necessary to the pyrometer installation on boiler uptakes as well as essential with the CO_2 recorder. The draft gage immediately indicates and interprets a low CO_2 reading as due to either an insufficient air supply by showing too little draft—or an overabundance of air from too much draft.

River Forest, Ill. WALTER T. RITTER.

Starting Induction Motors on Full Voltage

REPLYING to an inquiry in the March 18 number of *Power* relative to the starting of squirrel-cage induction motors on full voltage I submit a section of chart taken from a recording wattmeter. The two high readings *X* are graphic records of the operation of a 100-hp. squirrel-cage motor directly connected to a deep-well turbine pump and started by connecting it across the line. It will be noted that the load increase was approximately



Section of recording wattmeter chart

70 kw., almost doubling the existing load. It is evident that no excessive voltage occurred, as the corners of the record are square. No voltage chart was available.

The motor is rated at 100 hp., 3-phase, 400-volt, 121-amp., 50-cycle. Current is supplied from a bank of three 50-kva., 2,300- to 400-volt transformers, which also serve several other motors. These transformers, with several others, are connected to a bank of three 100-kva. 11,000- to 2,300-volt transformers drawing current from the public utility company's system. The company has no objection to the use of the motor, and the operation of other motors, as well as the lighting system, served through the same primary transformers, is not disturbed.

Norwalk, Calif. A. C. McHugh.

✦

STARTING a squirrel-cage motor on full voltage produces results both favorable and unfavorable to operator and power company. Since the latter has the "axe" on the operator, so to speak, starting of squirrel-cage motors 30-hp. and larger will be permitted only so long as its demand in starting will not exceed the standard set by the N.E.L.A., which is approximately 3½ times the nameplate current rating of the motor. This means that double squirrel-cage or auto-start type motors must be used before the inspector will pass such a hook-up and before the power company will consent to service it.

The successful development by manufacturers, and rapid acceptance by the trade, of the across-the-line motor is a major contribution to the progress of the squirrel-cage motor industry, especially from the standpoint of the purchaser. The characteristics of auto-start and across-the-line motors are in many respects ideal compared to the old squirrel-cage type started with a reduced-voltage compensator. Starting the latter produces two line surges, one at the moment of starting and the second at the moment the starter is thrown into running position. When the push-button operating an across-the-line type starter is pressed there is only one line surge, and the motor accelerates steadily to full speed.

Cases where stator windings are damaged by inrush or starting current are becoming fewer as a result of stronger slot construction, special bracing of coil ends and limiting the inrush current. R. H. Parrish,

Sales Engineer,

San Antonio, Texas. Alamo Iron Works.

Safety Valves on Water Heaters

CONCERNING the subject discussed in the April 8 issue of *Power,* in regard to providing a safety valve on hot-water tanks, I would like to cite a little incident that happened in Binghamton the past winter.

A coffee urn was heated by copper coils, which received the steam from the boilers used in heating a hotel, the pressure to the coils being reduced by a pressure-reducing valve.

The urn in question was not provided with a safety or relief valve. A hole developed in the coils, permitting the steam to escape into the urn. As a result a pressure was built up which blew the vessel up, causing approximately $500 damage, besides scalding two waitresses.

Had the urn been equipped with a relief or safety valve, this accident would not have occurred.

Chas. W. Carter, Jr.

Binghamton, N. Y. *State Boiler Inspector.*

Feed-Water Purification Systems

IN A recent number, S. T. Powell contributes an able article on feed-water purification. I differ from him on one statement, and that is that it is rarely the engineering force can be depended on to keep track of the water control and maintain maximum efficiency.

To cite a concrete case: I took charge of a raw-water ice plant some years ago, where the water supply contained 50 grains of calcium and magnesium salts to the gallon. As zeolite softeners do not yield clear ice without special treatment, a small lime-alum plant had been installed, which the chief engineer told me was no good and pointed to the ice as proof. This engineer was a capable man, but his education had been somewhat neglected. When the softener was installed, the demonstrator had told him that unless he had a high school education it would be impossible for him to understand it. This tactless remark did not please the engineer, so he made no effort to correct anything, but fed the lime and alum as directed.

I tested the hardness, increased the lime charge about 20 per cent and discarded the alum. Then I put a small shelf alongside the filter and placed a 150-cc. beaker and a weak solution of phenolpthalein in a bottle with a medicine dropper through the cork. Every few hours I drew the heater half full of filtered water and added 2 drops of phenol and shook the beaker. The engineer watched this, but said nothing for two days, then volunteered that the ice was coming through like glass, and asked me what to do if the test showed clear or very pink. Eventually he asked me to show him the soap and methyl orange tests. He knew "how," but not "why."

This article is not intended for the big plant where the chief engineer has a private office and a stenographer, but for the little fellow who has an 800 or 1,000 sq.ft. return-tubular boiler and a 60 hp. slide-valve engine, if there are any left.

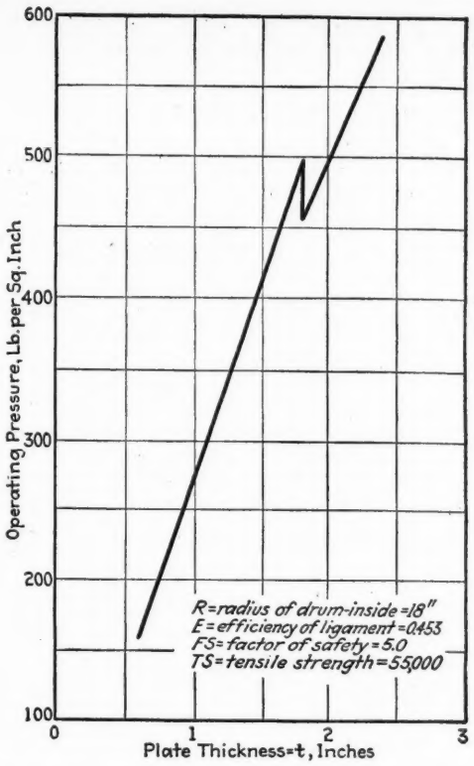
To him I would say: Build a water softener if you cannot afford to buy one. An ordinary wooden tank or an old boiler with an agitator or a pump will do. Mix a bag of calcium hydrate (slaked lime) in a barrel of water and pump the milk of lime into your tank. Let it settle and try the test referred to, if very pink, use less lime next time. Get or construct a small sand filter and take the feed from this through your heater or injector.

Crude, yes, but if you ever cleaned boiler flues on a hot Sunday and found by this time that you could run from twice to ten times as long without cleaning, you would say that my crude system was an improvement.

Mr. Powell evidently favors the zeolite system. It is good in water free from iron salts or where a previous lime softening has been used, but when used on a hard water it leaves as much sodium salts in the feed as there were magnesium and lime salts. These do not scale, but do cause foaming if the boiler is not blown down frequently, and blowing down is a waste of heat (and water when the latter is metered).

My preference is for a lime-barium-alum combination. The lime takes out the greater portion, the barium takes the rest, and the alum, which should be ammonia alum or aluminum sulphate, removes any excess of barium hydrate (a deadly poison if taken internally). A lime-strontium hydrate would give water comparable to rain water, but if all started using it, the price of strontium hydrate would be prohibitive, if it could be obtained at all.

Chicago, Ill. L. R. Baker.



Code rule permits 495 lb. working pressure for 1.8-in. thickness and only 465 lb. for 1.85 in.

Welding Specifications for Power Boilers

I READ in *Power* for March 25 a particularly interesting article on suggested specifications for welded power boiler drums. Many valuable suggestions will undoubtedly result, particularly along the lines of welding technique. Inasmuch as this discussion may be taken as the basis for code revisions, it seems pertinent to bring up a point in connection with the calculation of the maximum allowable pressure; which applies not only to riveted construction, but to any welded construction which may be allowed.

At present the A.S.M.E. code (P-180) gives as a formula for calculating the maximum allowable working pressure

$$P = \frac{(TS)(t)(E)}{(R)(FS)}$$

Where

P = Pressure, lb. per sq.in.
TS = Tensile strength of plate.
t = Thickness of plate in in.
E = Efficiency of joint or ligament.
FS = Factor of safety.
R = Inside radius of drum unless $t = 0.10R$ when
R = Outside radius.

Using the inside radius is the logical method when the plate thickness is small with respect to the radius, and it is obvious that some modification must be made in the method of calculation when the plate thickness becomes great enough, so that the probem becomes that of a "cyinder with thick walls." The unfortunate part, however, is that with the present method it is possible to increase the thickness of a drum plate and actually reduce the allowable pressure.

The attached chart shows the situation graphically for a 36-in. diameter drum and indicates that a plate thickness of 1.8 in. will be allowed a pressure of 498 lb., while a plate thickness of 1.85 in. is allowed only 465 lb. In fact, a 2.0-in. plate rates only the same working pressure as a 1.8-in. plate, even though it is 11 per cent thicker, certainly an anomalous condition.

The welded drums, if accepted, will have as their particular field the thicker drums, and it would be desirable if some method could be devised to eliminate this jump in drum thickness in the neighborhood of $1\frac{13}{16}$-in. plates for 36-in. drums, $2\frac{1}{8}$ in. for 42 in., and $2\frac{7}{16}$ in. for 48-in. drums.

ELMER S. SMAIL.

Oak Park, Ill.

Safety Work Must Be Continuous

WHEN success is achieved in safety work, it is sure to be only temporary if we feel the job is done. Safety is a continuous struggle that must be fought day and night, in the plant, in the home and on the street, against a foe that never surrenders. Neither will it allow time for rest. Good safety work is being done, but there is always rain with the sunshine, which in accident prevention work must not dampen our spirits.

The following are excerpts from the New York state accidents reports for 1929:

> "Compensation cost of state in 1929 greatest in history."
> "Total incurred by state fund in accidents to workers reaches $7,849,288."
> "Accidental injuries to industrial workers throughout the state increased greatly in 1929."

Such statements as these should indicate that we are losing ground in accident prevention work, rather than gaining, as we may be led to believe if the truth is not known.

These statements are advance information from the enemy as to what may be expected this year in his campaign against us. Therefore, if we fail to beat out last year's performance, the insurance companies and compensation boards will have the same bad news to report for 1930. The statements given out by the New York State Compensation Board should be an incentive not to relax in safety work.

Plant departments that went through 1929 without an accident have something to feel proud of, and are experiencing the thrill that follows a job well done. Would not that feeling of satisfaction be more triumphant and lasting if we would go through this year the same, while contributing some worthwhile suggestions and acts that will bring another department through without an accident at the end of the year?

Man has not, as yet, advanced to the stage of "Love thy neighbor as thyself." Neither is he, in the majority of cases, willing to lay down his life for that of his neighbor. He, therefore, will not consider the safety of his neighbor as seriously as he will his own.

A workman who was continually playing tricks on his fellow workmen, greased the hand railing on a short steep stairway to laugh at the other fellow when he fell. But the joke was on himself when he forgot about it and used the stairway and took the fall. Yes, if there is an unsafe condition in Bill's department and we pass it up, thinking that it does not interest us, we may be fooled by being injured instead of Bill.

MARIN PHILLIPS,
Electrical Superintendent,
International Paper Co.

Niagara Falls, N. Y.

From Among Readers' Problems

Conducted by
L. H. MORRISON

COMBUSTION WITH COMPRESSED AIR—*In our air compressor plant a fire occurred in the receiver but did no damage. As the compressor discharge was never over 300 deg. F., what caused the oil in the receiver to ignite?*

A.C.M.

A small piece of carbon on a discharge valve may have become so heated, due to poor cooling, that it began to glow. The amount of oxygen in a cubic foot of air at, say, 90 lb. gage pressure is seven times that in atmospheric air, and is enough to cause a rapid combination with the glowing carbon to produce a flame, which would ignite any oil in the receiver.

ALLOWANCE FOR STRENGTH OF GIRTH SEAMS—*In computing the strength required of girth joints of a horizontal return tubular boiler shell, what allowance should be made for the reduction of area of the heads due to the tubes?*

W.L.C.

According to the A.S.M.E. Boiler Code, par. 184, b: "When 50 per cent or more of the load which would act on an unstayed solid head of the same diameter as the shell, is relieved by the effect of tubes or through stays, in consequence of the reduction of the area acted on by the pressure and the holding power of the tubes and stays, the strength of the circumferential joints in the shell shall be at least 35 per cent of that required for the longitudinal joints."

HEAT IN ENGINE EXHAUST—*We are generating 1,000 kw. per hour, with a boiler pressure of 200 lb., no superheat, and exhausting into the atmosphere. The water rate is approximately 34 lb. per kilowatt-hour. At the same time we draw 25,000 lb. of steam from the boilers for process work, the steam passing through a reducing valve to reduce the pressure to 15 lb. gage. Could the engine be used for process and just how many pounds of steam would be saved, considering both the engine and the process?*

P.V.L.

At 200 lb. initial pressure and zero gage back pressure, a perfect engine will take out of each pound of steam 1,199.2 — 1,004.9 = 194.3 B.t.u., so assuming that to care for frictional and electrical losses 4,000 B.t.u. is needed to deliver a kilowatt-hour on the switchboard, 4,000 ÷ 194.3 = 20.6 lb. (approximately) of steam will be taken by a perfect engine. As the actual engine has a water rate of 34 lb., its Rankine efficiency ratio is 20.6 ÷ 34 = 60 per cent. If the back pressure is raised to 15 lb. gage the ratio of the actual engine's efficiency to that of the perfect engine should remain at about the same value of 60 per cent.

It is now necessary to find the steam consumption of the perfect engine when operating with an exhaust of 15 lb. gage. This is approximately 27 lb. The actual engine will then use 27 ÷ 0.60 = 45 lb. of steam per kilowatt-hour.

Measured from feed water at a temperature corresponding to 15 lb. gage, that is 250 deg. F., each pound of steam at 200 lb. gage has had added to it 1,199.2 (total heat at 200 lb. gage) — 218.8 (heat of liquid at 250 deg. F.) = 980.4 B.t.u. To develop 1,000 kw.-hr. will require 1,000 × 45 = 45,000 lb. of steam; to which has been added 45,000 × 980.4 = 44,118,000 B.t.u. Of this, 4,000 × 1,000 = 4,000,000 is transformed into mechanical power, leaving 40,118,000 in the 15 lb. exhaust for process steam.

As the latent heat of steam at 15 lb. gage is 945.1, the exhaust supply is equivalent to 40,118,000 ÷ 945.1 = 42,448 lb. per hour.

Since 25,000 lb. of 200 lb. steam is now put through a reducing valve for process work, which, measured from 250 deg. process condensate, gives a total of 25,000 × (1,199.2 — 218.8) = 24,510,000 B.t.u., it is obvious that the exhaust will be more than ample for the process.

You then have a direct comparison between the present total steam consumption of 34,000 + 25,000 = 59,000 lb. of steam hourly, and the consumption of 45,000 lb. if the engine is to exhaust against 15 lb. back pressure. It would pay to make the change if the processing is such that the oil in the exhaust is not objectionable.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

HOW can I calculate the piston speed and mechanical efficiency of a simplex and a duplex steam pump? L.M.B.

CHANGE the reading on the Venturi meter from pounds to gallons per minute; then the piston speed to pump that many gallons will be:

$$\frac{Gal.\ per\ min. \times 231}{S \times A}$$

When S = The length of stroke, in inches.

A = The area of the water end in square inches.

To calculate the mechanical efficiency of the pump take an indicator diagram from the water end of the pump, and take one from the steam end of the pump, and 100 multiplied by hydraulic indicator diagram in pounds per square inch divided by the steam indicator diagram in pounds per square inch will be the mechanical efficiency of the pump.

PERLEY THURSTON.

West Concord, Mass.

ANY MACHINE'S mechanical efficiency is the power received from the output end divided by the power imparted to the input end. For a steam-driven pump it will be the ratio of the power developed in the liquid end to that of the steam end. For outside-driven pumps it will be the ratio of the water horsepower output to the brake horsepower input at the coupling or pulley. Stroke and type of liquid end also govern this condition. The plunger-type pump with four outside stuffing boxes will have greater friction than a piston-type with two inside-packed pistons.

As to piston speed, the displacement formula for single-cylinder, double-acting piston is:

$$D = \frac{A\ P\ (12)}{231} = .048d^2\ P$$

where D = Displacement in gallons.

A = Area of piston or plunger, sq.in.

d = Diameter of piston plunger, in.

P = Piston speed in feet per min.

For a simplex single-acting pump

divide the answer by 2. For a duplex double-acting pump multiply by 2.

S. ROSENBERG,
Inspector, Panama Canal.

Canal Zone, Panama.

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THE mechanical efficiency of a steam pump is the ratio of horsepower developed in water cylinders to the indicated horsepower of steam cylinders. The horsepower of water cylinder = $\frac{W\ (H-h)}{33000}$, where

W = Pounds of water pumped per minute.
H = Discharge head in feet.
h = Suction head in feet (added when suction is below, and subtracted when above, the center of water cylinder).

The indicated horsepower of steam cylinder = $\frac{1\ Plan}{33000}$. One must not fail to calculate both cylinders of a duplex pump.

If "L.M.B." only wants to practice calculating mechanical efficiency he can get the cylinder diameter and the length of stroke from the nameplate, and assume a steam pressure, speed, total head in feet, and weight of water pumped per minute.

To actually check pumps he should have indicators, one for each steam cylinder of the duplex pump and in the absence of a counter he can check the strokes per minute by a watch.

In making the test start the pump, regulate the speed and discharge pressure. Note time and start, weighing the water. At frequent intervals take indicator diagrams, checking the stroke and speed. Plotting both to obtain a mean of each, also check the discharge pressure. If desired, a thermometer can be used to correct for temperature. The piston speed can be obtained by multiplying length of stroke in feet by the number of strokes per minute. For the duplex pump, check each piston stroke separately, or multiply the result of one side by 2.

S. B. CONKLIN.

Baldwin, N. Y.

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PISTON SPEED can readily be calculated by measuring the stroke of the pump along the rod. Put a pencil mark on the rod close to the gland when the pump is at the beginning of its stroke. Using a pair of inside calipers or dividers, measure from the gland to this mark when the pump has reached the opposite end of its stroke. Multiplying this distance by the number of strokes per minute will give the piston speed.

To calculate the mechanical efficiency simply divide the output by the input of the power end.

For example, assume that a simplex boiler feed pump having a steam piston 10 in. in diameter, water piston 8 in. in diameter, stroke 8 in., with steam pressure at 100 lb. and water discharge pressure 150 lb., makes 60 strokes per minute, with a delivery of 80 gal. water per minute. To find the mechanical efficiency the theoretical output from the water piston must first be determined. Call it G.

Thus

$$\frac{d^2 \times .7854 \times length\ of\ stroke \times N}{231\ \text{cu.in.}} = G$$

$$= \frac{8 \times 8 \times .7854 \times 8 \times 60}{231} = 104.4$$

As *mechanical efficiency* = $\frac{output}{input}$, we can set down $\frac{P\ L\ a\ N\ g}{p\ L\ A\ N\ G}$

where

p = Steam mean effective pressure.
L = Length of stroke.
A = Area of water piston.
a = Area of water piston.
N = Number of strokes per minute.
G = Theoretical gallons delivered per minute.
g = Actual gallons delivered per minute.

By substituting the values assumed, the mechanical efficiency is found to be 73.8 per cent.

It will be easily seen that this method of calculation is readily adaptable to a simplex. or a duplex pump.

GEORGE MCNALLY,
Ford Motor Co.

Kearny, N. J.

—◆—

THE PISTON SPEED can be calculated for a single double-acting piston pump from the formula:

$$P = \frac{231\ D}{A\ 12} = \frac{D}{0.408\ d^2}$$

where P is the piston speed in feet per minute, D the displacement in United States gallon per minute, d the diameter of the piston or plunger in inches. For a simplex single-acting pump divide by 2, and for a duplex double-acting pump multiply by 2.

Stroke, Inches	Efficiency, Per Cent—Piston Type to 250 Lb.	Packed Plunger to 300 Lb.	Pressure Pump to 1,000 Lb.
3	50	47	45
4	55	52	50
5	60	57	54
6	65	61	58
8	70	66	63
10	75	71	67
12	77	73	69
15	80	76	72
18	82	78	74

The mechanical efficiency of a pump varies with the stroke and the type of liquid end. A packed-plunger pump with four stuffing boxes has a greater friction loss than a piston pump with two inside-packed pistons. The mechanical efficiency of a pump can be found by application of the formula:

$$\frac{Plunger\ load\ in\ pounds}{Steam\ piston\ force} = Mechanical\ efficiency$$

The plunger load equals the area of the liquid piston or plunger multiplied by the total dynamic head expressed in pounds per square inch. The total load to be overcome by the steam is composed of the plunger load plus the mechanical friction of the steam and liquid ends. This load is called the "steam piston force." It is equal to the mean effective pressure multiplied by the area of the high-pressure steam piston. The formulas for calculating the mean effective pressure for simple, compound- or triple-expansion steam ends will be found in textbooks.

The table indicates the efficiencies that should be attained with a pump in good operating condition.

JULES CONLON.

New York City, N. Y.

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THE PISTON SPEED of direct-acting simplex and duplex pumps is found by multiplying the number of strokes per minute by the length of stroke in inches and dividing by 12. This gives piston speed in feet per minute.

The mechanical efficiency of these pumps is calculated by the following formula:

$$Mechanical\ Efficiency = \frac{100\ Pwhp}{Pbhp}$$

In which

Pwhp = Hydraulic horsepower as found by the pump indicator diagram.

Pbhp = Input or driving horsepower.

Indicator diagrams are taken with the indicator and computed with a planimeter and are always found to be rectangular in shape, inasmuch as the steam piston is acted on by live steam for the full length of stroke, there being no cutoff, as in a direct-acting steam engine. This accounts for the low efficiency of a pump of this type, as the expansive property of the steam is not utilized.

DONALD KINCAID,
International Shoe Co.

Flora, Ill.

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[All the answers received failed to point out that a mere measurement of one stroke of a duplex pump does not give a value that may be used in computing the piston speed in feet per minute. Duplex pumps do not always have a constant stroke, and the variations will seriously affect the piston speed. The mechanical efficiency steam-driven pump is so difficult to calculate that it is customary to include with it the hydraulic efficiency, so that mechanical efficiency may be taken as the instantaneous water horsepower being developed divided by the instantaneous steam indicated horsepower, the latter to be computed from indicator diagrams.—L.H.M.]

A Question for Our Readers

IS IT safe to blow down the water walls of a 325-lb. boiler while the boiler is under load? C.A.MCC.

Suitable answers from readers will be paid for and published in the May 20 number.

Public Control of Power Debated

By Political Science Body

Power matters of vital public interest found a forum at the semi-annual meeting of the Academy of Political Science, held on April 11 in the Hotel Astor, New York City. "Public Control of Power" was the subject of discussion at an all-day session of this scholarly society, now in its fiftieth year. Well-known economists, college professors, judges and utility operators presented views on the subject of utility regulation.

ALBERT SHAW, vice-president of the Academy, and editor of the *Review of Reviews*, presided at the morning session, at which the speakers were: William E. Mosher, professor of political science and managing director of the School of Citizenship and Public Affairs, Syracuse University; Henry C. Spurr, editor of *Public Utilities Reports Annotated;* William A. Prendergast, New York City; John H. Gray, professor and head of the department of economics, Graduate School of American University, Washington, D. C.

A sharp difference of opinion was made evident at this session. Professor Mosher pronounced regulation as now practiced largely a failure in its primary function of rate control. Professor Gray went further in the same direction, challenging the whole theory of rate making now in vogue as fundamentally unsound and practically unworkable.

The commissions and utilities were defended with equal vigor by Mr. Spurr and Mr. Prendergast, the latter having recently resigned as head of the New York Public Service Commission after a dispute with Governor Roosevelt.

REVIEWING 25 years of regulation by state commission, Professor Mosher pointed to the early corruption and general chaos that led New York State to form a utility commission under the leadership of Governor Charles Evan Hughes. Only Wisconsin preceded New York. Other states soon followed along similar lines.

Admitting the present successful operation of the commission in many matters, Professor Mosher insisted that conditions are now very bad, particularly in the matter of regulating rates in the public interest. He cited court precedents, lack of initiative by the commission, lack of adequate personnel for value surveys, and the growing complexity of utility operations as prime reasons for this situation. He disagreed absolutely with the contention that rate schedules are scientific, and spoke of "fair value" as the most perplexing problem.

In reference to holding companies, Professor Mosher remarked, "Without the possibility of contradiction it may be said that no utility commission in the country has the authority under the law to exercise adequate control over holding companies which in certain utilities have taken over practically all of the important functions formerly centered in the management of operating units. The holding companies have performed important and salutary services. But, on the other hand, by reason of the fact that they are controlled by financiers rather than utility officials, they have introduced the profit motive and made of the public utilities one of the most speculative industries in the country.

"The Public Service Commission must have the proper authority to demand access to the books and records of holding companies if it is to keep pace with the utility management as it has now developed, and to this end legislation is being considered by the state legislatures not alone in this but in other states."

REFERRING to rates, he pointed out, "A shortcoming going to the very heart of utility regulation is in connection with the determination of values for rate-making purposes. There may be one or two commissions in the country, but there are not more, that have the data available for determining the rate base. The record of the hearings before the recent investigating committee goes to show how inadequate the material is for this purpose which is at the disposal of the New York commission. Utility managers assert that reproduction cost new minus depreciation is the determining factor and scout the importance of book values, while the Public Service Commission is inclined to lay considerable stress on book values as the rate base."

In closing, Professor Mosher urged the need for leadership in the solution of regulation problems.

The commissions were stoutly defended by Mr. Spurr, who pointed out the continued improvement of service and the insistence of the commission on fairness to the consumer in all disputes. "Most of the criticism of public utilities," he pointed out, "simmers down to a mere difference of opinion as to the reasonableness of rates and the proper method of arriving at the rate base. The opponents of regulation say that the courts have established an improper rate base and that therefore commission regulation has broken down."

But, he pointed out, only a small minority of cases ever get to the courts. Mr. Spurr deprecated an attitude that would starve utilities and result ultimately in loss to the consumer.

PROFESSOR GRAY'S ADDRESS was a militant attack on the present theory and practice of regulation. He said that the commissions have failed completely to protect the public in their major function of rate making. "Fair value" and "replacement value," he averred, are useless and meaningless fictions whose principal functions in practice is to make possible endless confusion and concealment of facts. Rates, Professor Gray insisted, are actually what the traffic will bear, just as if no regulation existed.

Professor Gray went further and questioned the operation of government in respect to all big business, saying that competition as a means of holding prices in check has lost its power in many lines outside of the utility field.

In the utilities, he asked, how can rate structures be checked when the commissions have no adequate cost data, no strong desire to get it and no adequate force for its collection? Social policy, he concluded, is the only intelligent basis for rate fixing and distribution.

In the concluding address of the morning session—a strong defense of the commission and the courts—Mr. Prendergast pointed out that the commissions are quasi-judicial bodies.

"There are certain inherent principles," said Mr. Prendergast, "in the regulative theory. It was established to secure fair dealing for all and to prevent persecution of any interest. These principles are simple and should be well understood.

"1. The consumer is entitled to just and reasonable rates for the service or commodity he buys from the utilities.

"2. He is equally entitled to ample service and every possible measure of safety in the supplying of that service.

"3. It is the duty of the commission to see that the consumers are given adequate protection in the enjoyment of these rights.

"4. The property of the utility is private property, devoted to a public use, and the investors in that property are entitled to every protection of the law

(equally with the consumers) and to a fair return upon their investment.

"5. Their investment is entitled to protection against the unfair attacks of politicians and self-seeking complainants and they have a right to look to the commission for this protection."

At the afternoon session, presided over by Edwin R. A. Seligman, professor of political economy at Columbia University, experimentation in new methods of utility control, new valuation principles and more rigid regulation were demanded by James C. Bonbright, professor of finance at Columbia University, and Robert L. Hale, professor of legal economics at the same university. Martin J. Insull, president of the Middle West Utilities Company, and Randall J. Le Boeuf, general counsel of the Niagara-Hudson Power Corporation, defended the present principles of control and attacked suggested changes. Lewis Goldberg, commissioner of the Massachusetts Department of Public Utilities, discussed public utility regulation in his state.

RATE REGULATION of public utilities has become a farce, has completely broken down under the fallacious judge-made rule that rates should be based on valuation of property, while values themselves depend on profits, and fundamentally different system of rate control is necessary if regulated private ownership is to be made a success, declared Professor Bonbright, who led in submitting the minority report of the Knight Commission on the Revision of the Public Service Law in New York State.

He urged that experiments be made with various methods of control—government ownership and operation where conditions were ripe for it, in other cases consumer ownership, and in others private ownership with almost no control of profits. But especially he thought it important to give the prudent investment principle, as suggested in the minority report, "a thoroughgoing chance to prove the merits which a long list of distinguished advocates such as Mr. Justice Brandeis, the majority of the Interstate Commerce Commission, and the Massachusetts Public Utility Commission have claimed for it."

THE MINORITY REPORT, he said, "accepts the principle that utility companies should charge such rates as will insure them a reasonable return on the actual legitimate costs of their property. Recognizing, however, that investors have already committed their capital under a different system of regulation, the plan of the minority would give to these investors not merely fair but generous treatment by allowing them to earn a return on a rate base measured by what the courts now falsely call the present value of the property.

"Unearned increments to which utility investors are already entitled under the law of the land would thus be accorded them, but the door should be locked to the accretion of vast unearned increments in the future, and on the other hand investors would be safeguarded to a greater extent than they are today against unexpected decrements."

Regulation has broken down, concluded Professor Bonbright, because utilities do not want rates based on present value.

Opposing any change in the present status, Mr. Insull spoke in favor of state regulation of operating companies, but urged that holding companies have complete freedom of action. Experience proved, he asserted, that regulation, though not perfect, was better than public ownership. He cautioned politicians that ownership and operation of utilities was not as simple as regulation.

MR. INSULL urged full understanding between operating companies and state commissions on the charges made for services rendered by holding companies. He pointed out that holding company security issues have no connection with operating company rates, which are based on value of property rather than capitalization. The protection of the investing public, he maintained, is already provided for by regulating commissions which supervises the sale of securities in most states.

"The freedom of action of the holding company," he said, "has enabled it to do the great work it has in the development of the electric industry in this country to a pre-eminent position in the whole world. Without it, that development would not have taken place and future development would be materially retarded.

"In many ways the freedom of action of the holding companies has made electricity cheaper, in its financing of the wide transmission and distribution systems fed by up-to-date economical generating units, in its constant efforts for lower costs of production of its operating units for them to be able to compete kwith all other price movers for the industrial power business of the nation and to increase the diversity of the residential business to the end that everyone may be supplied at continuously lowering rates."

SPEAKING of the "contract method" of rate regulation recently suggested in revision of the New York public service commission law, Mr. Le Boeuf stated its adoption was urged on the basis that the existing system of control had broken down. This breakdown, he argued, was greatly exaggerated by partisans and theorists. Politicians are not interested in the rates consumers pay, he said, but rather in the surrender by slow degrees of private to public ownership.

Admitting he was a theorist, whom he defined as one not paid to give opinions, Professor Hale launched into a vigorous defence of the Bauer principle of valution. Under this plan, he said, legal restrictions would be imposed which, while not unconstitutionally reducing value, would prevent it from fluctuating with reproduction cost. He concluded with a detailed analysis of court decisions to show that there was nothing in the decisions of the Supreme Court requiring a fair return on fair value which would render the Bauer plan unconstitutional.

The success of utility regulation in Massachusetts was described next by Mr. Goldberg. He said "Massachusetts believes that public utilities should be so regulated as to serve at all times the best interests of the public and the utilities. We believe that these results can be most fairly and effectively accomplished by basing valuation on the amount of money honestly invested by the stockholders in the utility and by having an elastic or variable rate of return. Under this view the rate base is at all times certain, stable and easily determined. By an elastic rate of return we can adjust the rate to the needs of the specific utility and to changing economic circumstances.

"IN THE last few years some of the electrical utilities seriously began to urge as a rate base reproduction cost of the physical property less depreciation, embellished by intangible values. These intangible factors of value seem to be confined only by the limit of the ingenuity of experts. In one case a pond which, together with some land, was purchased several years prior to the hearings for $69,000 was valued by experts on the reproduction theory at $1,200,000. An office building 50 years old, located in the heart of the city, was depreciated for rate-making purposes only 5 per cent of the reproduction cost, for the entire 50 years. We learn that cast-iron pipes should not be depreciated at all, because such pipes laid in the days of the Caesars were dug up in Rome and still found to be in good condition.

"Our experience in Massachusetts with the attempt to make reproduction cost less depreciation, the rate base has been that it fosters litigation, prolongs rate cases ad nauseam, piles up expenses for experts and counsel which the consumer ultimately must pay, engenders ill-will toward the utility, and tends to make regulation ineffective. In my opinion, a threatened breakdown of effective regulation would never be tolerated by the people of Massachusetts. It would drive us to public ownership. I do not advocate municipal ownership. I would rather see this service performed by private companies, properly regulated by public authority.

"THE PROBLEM of regulation of electrical utilities has become more complicated by the rapid development of holding companies. To prevent abuses by the holding companies, we believe that the public regulatory body should have the power in any rate case to pass upon the reasonableness of the price paid by local electrical utilities for power and also to pass upon the fairness of the price paid to the holding company or its subsidiaries for services. Four years ago such a statue was enacted by our Legislature with respect to the purchase of power by the local companies, and there is now pending before our Legislature a similar statute with respect to contracts for services.

In the discussion that followed these addresses, Noel T. Dowling, professor of law at Columbia University, pointed

out that the growth of interstate power made it an increasingly important factor and some form of regulation should be devised to control it. As in the case of prohibition, he said, the federal government could delegate the power of this regulation to the states.

At the well-attended dinner meeting, presided over by William L. Ransom, acting president of the Academy, Col. William J. Donovan, counsel of the New York State Commission on the Revision of the Public Service Commission Law, reviewed the history of public utility regulation and called for "reconciliation of the basic interests of the state and of our economic institutions to insure that these institutions shall be the servants and not the masters of the people." The leaders of public utilities, he said, must accept the principle of partnership and actually apply it. He further pointed out that the electric utilities are not monopolies in the strictest sense, because they have to meet stiff competition from the many industrial power plants.

Judge Martin T. Manton, of the United States Circuit Court of Appeals, defended the practice of the federal courts in accepting jurisdiction in certain rate cases. "It is the deprivation of property without due process of law," he said, "that warrants the public utilities to make contest against any state regulatory bodies created by statute when the rates fixed by these bodies constitute a confiscation of property."

THE NEED for mutual understanding between parties concerned in the public utilities problem was urged by Floyd L. Carlisle, chairman of the Niagara-Hudson Power Corporation. He warned against "the tremendous cost to the state" if public ownership of gas and electric utilities should come about, estimating it at $4,000,000,000 and the yearly loss of $50,000,000 in taxes now paid to the State by utility companies.

He concluded with the statement that "the objectives of public utility companies should and must be to give the best possible service at the lowest possible rates. Such rates must be sufficient to give to the investors in the companies reasonable certainty of return upon the fair value of the property rendering the service and to attract the tremendous amounts of new capital needed annually for expansion. Such rates must be high enough to permit the payment of adequate and equitable taxes to the local, state and national governments, to permit proper depreciation, obsolescence and adaptation to the constant changes and new discoveries occurring in the electrical business and to permit the payment of fair and remunerative wages and salaries to the employees of the companies and to care for them when injured, sick and aged.

"To attain these objectives it should not be necessary to resort to continuous rate cases and court reviews. The doors of the company should be wide open to its consumers, to municipalities and to the commissions to discuss and receive information concerning the company's business."

Power Industry's Coal Problems Discussed at Purdue Conference

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The uses, availability and suitability of Indiana and Illinois coals to various domestic and industrial applications; a working demonstration of domestic and semi-industrial stokers; comments on the problems of producers and distributors; suggestions on reconditioning existing plants; and a plea for research were subjects at Mid-West Bituminous Coal Conference

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AS AN OUTGROWTH of the Indiana Fuel Conference that had been sponsored by Purdue University for the past two years, the Midwest Bituminous Coal Conference, including the coal interests of Illinois as well, held its initial educational conference at Lafayette on April 9 to 11, under the direction of the Engineering Extension Department and School of Mechanical Engineering of Purdue University, the Coal Trades Association of Indiana and the Illinois Coal Bureau, with the University of Illinois, the Fuel Division of the American Society of Mechanical Engineers and the Indiana branch of the National Association of Power Engineers participating.

For the first time in the history of the coal industry all interested parties —the producer, the distributor, the user, and the allied interests of the heating industries—were represented in a conference planned to bring out the problems of distribution and uses of Mid-West bituminous coals. By an interchange of information between the various branches of the industry it was hoped to impress upon all concerned the need for co-operation and for a well-defined program of research that by improving the economies and the conditions surrounding the use of these fuels would restore and perhaps increase the production of former years.

Much attention was given to the automatic domestic stoker, as its successful adaptation offers the greatest opportunity for new and larger markets.

Indicative of the interest taken in the conference, the total registration exceeded 500. At the banquet, which was made an outstanding feature of the meeting, the attendance was over 300. As to results, it is probable that lasting benefits will ensue. Each branch of the field will be more familiar with the problems of the industry as a whole, will better understand the necessity of working together and the need for research to develop the most efficient use of the coals of the two states. It was the consensus of opinion, emphasized by repeated utterance, that the dealer no longer can afford to be a mere purveyor of coal. He must sell heat on the service basis, and in assuming the rôle of fuel adviser he must be familiar with the principles of combustion and know the physical and mechanical conditions under which the coal he is handling can be used to best advantage.

A resolution made as the closing event of the meeting indicates that this conference will continue. A committee is to be appointed to decide the time and place, although it is the general understanding that the next meeting will be held at the University of Illinois, and that the conference will then alternate between there and Purdue.

A. A. Potter, dean of the schools of engineering, welcomed the conference to Purdue. The opening session was devoted to the economic justification for greater use of Illinois and Indiana coals in the Middle West. Paul I. Richey, president of the Indianapolis Chamber of Commerce, and C. G. Ferris, executive vice-president of the Illinois State Chamber of Commerce, presented interesting data showing the economic boundaries of the market as determined by freight rates, the falling off in consumption in recent years, and some of the causes for the decrease, with suggestions as to how improvement might be effected.

SUITABILITY of Illinois and Indiana coals for power, industrial and domestic uses was discussed, in respective order, by A. D. Bailey, of the Commonwealth Edison Company; W. D. Langtry, president of the Commercial Testing and Engineering Company; and C. H. B. Hotchkiss, associate professor of heating and ventilating at Purdue University. In an industry that continues to use more coal year after year, notwithstanding lower consumption per unit of output, Mr. Bailey pointed to the excessive cost of moisture, ash and sulphur in coal. How to avoid paying freight rates on these ingredients and to eliminate the troubles they were causing should be a subject for research, he contended. Low-temperature carbonization did not look so good, as the sulphur still remained in the gas and the ash in the coke. Cleaning at the mines costs too much. The power end of the industry has used, and will continue to use, these coals in spite of the handicaps; but in his opinion something should be done by the dealers to remove the objectionable features.

W. D. Langtry pointed out that the coals under discussion could be used satisfactorily in every kind of industry in which coal is the fuel. Classification on a broad scale will help in its selection, but actual trials in the plant should determine the most economical.

PROFESSOR HOTCHKISS said that as the heating plant followed the weather, it must be flexible and necessarily be operated on a low load factor. To keep down the overhead the installation must be simple. The plants in this field were classified, with tabulations to show the general type of equipment to be found in each, and comment was made on the considerations that would determine the choice of the fuel. In domestic heating cost is not the factor to be emphasized, as comfort and convenience must come first.

At an evening session there were papers enlarging upon the use of Illinois and Indiana coals in the ceramic and the glass-making industries. In the ceramic field, Prof. C. W. Parmelee stated that coal of good quality, high heat value, long flame travel and a sulphur content of not more than 1 per cent is desirable. Properly selected coals from the two states are suitable. Uses of stokers, powdered coal, oil and producer gas were considered and comment was made on the influence of the fuel contents on the qualities of the ware.

"Mechanical vs. Hand-Poked Gas Producers" and the "Use of Indiana Coal in Gas Producer Practice" were interesting papers presented at this session by Victor Windett and O. L. Scales. The former gave an excellent idea of the relative cost of producer and other kinds of gas and of the requirements for the efficient operation of a producer. Mr. Scales gave the following qualifications for a good producer coal: Uniformity of size, an ash-fusing temperature of 2,200 deg. F. or above, and volatile not to exceed 42 per cent. Ash in excess of 8 per cent is burdensome in a producer. The process of gas generation was explained and detailed instructions were given on how to use Indiana coal in a producer.

AT THE Thursday morning session T. A. Marsh, consulting engineer of the Combustion Engineering Corporation, outlined the interests in the fuel-burning field that were common to the stoker manufacturer, the coal retailer, the combustion engineer and the educator. Briefly stated, these problems are to provide better heating service to the purchaser, to effect economies so that heating and power bills will be lower, to produce smokeless combustion, to provide maximum convenience by automatic operation, and, finally, to make a profit in the respective business. It seems logical in the future that the small domestic stoker might be sold by the retail coal dealer. Definite standards of stokers and their application, together with the furnaces and conditions surrounding the installation, must be established, and there should be, as well, performance information relating to the proper sizes of coal and the results to be obtained therewith. One of the factors retarding the heating and the coal industries today is the deficiency of men properly trained in specific installation work and in the selection of coal to meet definite requirements.

The remainder of the session was given over to a symposium on mechanical stokers for domestic and semi-industrial application, at which representatives of the Combustioneer, the Iron Fireman, the Modern Coal Burner, and the Harrington stoker, discussed relative and specific advantages of this type of equipment. A progressive indication was the announcement that the small stoker manufacturers are organizing to formulate proper standards for operation, and, of primary importance, a code of ethics.

COAL DEALERS had their inning at the afternoon session. That co-operation was the keynote is indicated by the following titles of papers presented: "The Dealer as Fuel Counselor in His Community," "The Retailer Looks at Co-operation," "Better Relationship Between Coal Merchant and Heating Contractor," "Satisfactory Heat — A Product of Co-ordination," and the "Relation of the Coal Industry to the Consumer." It was generally agreed that all branches of the coal and heating industries should co-operate, and that the retailer should assume the new rôle of fuel counselor, as service has come to mean everything in dealings of public contact. As an indication of what might be done, George F. Klein told how the Coal Service Institute of Kansas City is serving the public.

Dr. Edward C. Elliott, president of Purdue University, presided at the banquet. Short talks were made by many of the officials of the various organizations represented. Fred Raven and Lisle A. Pierson spoke in behalf of the National Association of Power Engineers. Governor Leslie of Indiana expressed pleasure at the co-operation between Illinois and his state in trying to solve the coal problem. His desire and that of all of the citizens of Indiana is to assist the industry in every way possible, he said. Being an essential industry, he wishes to see it prosper.

Homer R. Linn, engineer of the American Radiator Company, was the principal speaker of the evening, and his topic was "Industrial Research and Its Relation to the Coal Industry." Telling his audience that industrial research simply meant the application of scientific facts to the solution of problems, Mr. Linn proceeded to recount what various organizations had done in the way of research. His special plea to the coal operators and merchants of Indiana and Illinois and to the bituminous stoker manufacturers was to start intensive and comprehensive research. Coal is now looked upon as an essential, he said. How long it will remain so, depends upon what the coal industry does to insure the continuance of economical and satisfactory use of the fuel. As an intimation of what might be done, the speaker summarized some of the problems awaiting a definite research program.

FROM a practical standpoint, the final session was interesting, as it dealt with the reconditioning of existing plants, the three phases of the subject—justification, methods and examples—having been assigned to as many speakers. A. C. Willard, head, and A. P. Kratz, research professor, Department of Mechanical Engineering, University of Illinois, outlined the objectives in reconditioning heating plants, and pointed to the need of better information on the proper relation between primary and secondary air and on the handling and adjustment of mechanical stokers to burn the cheaper grades of coal. The greatest possible gain in reconditioning heating plants is to be obtained by paying attention to the combustion processes, they said. Experiments at the University of Illinois have shown that much of the assumed wasted heat is utilizable, as the so-called loss is maintained within the walls of the building. The problem is to balance the heat loss from the house against the heat output from the furnace. The chimney loss being much the largest, gives an excellent check on the loss from the building. The authors gave an interesting summary of what has been done at the university in determining over-all building efficiency.

Frank Chambers, chief inspector of the Chicago Smoke Department, reviewed some of the smoke abatement problems encountered in the burning of Indiana and Illinois coals. Little has been done toward the elimination of smoke from heating plants, but he declared he had been encouraged by the recent development of the small stoker and the promise of research in field and plant toward the economical and smokeless burning of these fuels.

IN DISCUSSING the reconditioning of existing plants, John Hunter described the action of bituminous coal hand-fired on an incandescent fuel bed and referred to the original tendency to place the heating surface as close to the fuel bed as possible, with the inevitable result that the volatile gases were chilled and passed to the stack unburned. Coking arches, extension furnaces and larger furnace volume have helped to relieve this condition. The speaker commented on the various types of stoker that have been developed to increase economy and capacity, and outlined the generalities that apply to all sizes and types of plant contributing to efficient and smokeless operation. With the cheap coal available he does not consider stokers in the average home justifiable. To eliminate the smoke he favors compulsory use of a smokeless fuel. Such a fuel could be provided by low-temperature distillation. For the larger heating installations he classified the various types of equipment to be had, discussed their performance and suggested how improvements could be effected in their operation.

WHAT'S NEW IN PLANT EQUIPMENT

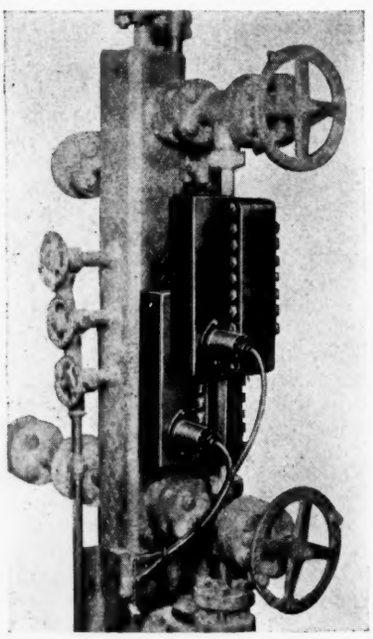
HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Improved Illuminator for High-Pressure Water Columns

IN THE improved type L illuminator for high-pressure water columns using the flat glass bolted into heavy casting, the same optical principle employed in the types B and D put out by the same manufacturer, the National Company, Inc., 61 Sherman St., Malden, Mass., is retained.

Light from a standard 150-watt lamp is directed upward by a chromium-plated parabolic mirror set at an angle of 45 deg. A series of metal louvres prevents the passage of light at any other angle so that no stray light escapes. The upward beam is totally reflected by the underside of the surface of the water, causing a brilliant spot of light. The rest of the gage glass remains in darkness. The contrast of the brilliant meniscus against the unlighted background makes the water level easily visible from a considerable distance.

The mounting is comparatively simple, permitting the illuminator to be easily removed for replacement of gaskets or glasses. A steel hook or clamp engages the top of the gage in such a way that the weight of the illuminator causes it to lie close to the glass, while the louvre assembly, extending between the face-plate nuts, prevents side motion, the entire illuminator being readily removed by loosening one bolt and pulling the plug on the electrical connection. The lamp socket may be attached to either side of the illuminator, to permit installation where space is limited.



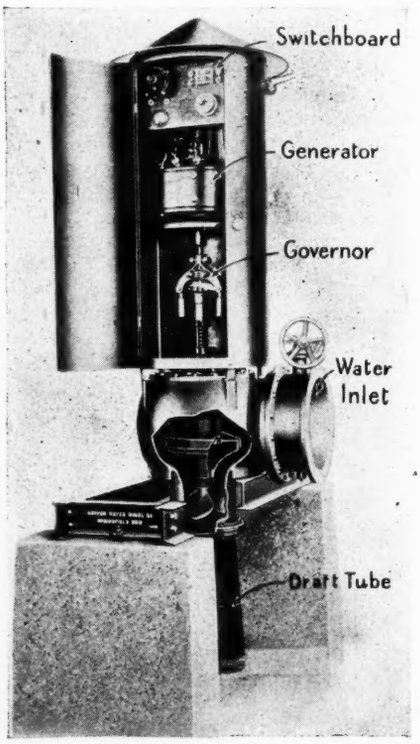
Illuminator applied to a high-pressure duplex water gage of the flat-glass type

Small Hydro-Electric Plant for General Service and Emergency Lighting

ALTHOUGH designed primarily for generating light and power from the small low-head streams, the small hydro-electric plant illustrated, put out by the Hoppes Water Wheel Company, Springfield, Ohio, is suitable for use as an emergency lighting set in power and industrial plants and buildings. The unit is completely inclosed and self-contained, with the governor, generator and switchboard mounted in a cylindrical ventilated, sheet-metal housing, as shown.

The runner is of the conventional propeller type, and the water admitted to it is regulated by means of the cone-shaped valve directly above it, operated by the governor. The valve slides on a hollow stem extending downward from the top of the casing. It is supported in an open position by a coil spring and is moved downward by the governor to regulate the amount of water to the runner. A dash pot formed by the upper end of the valve prevents it from closing too quickly.

An important feature of the unit is the compact arrangement of the

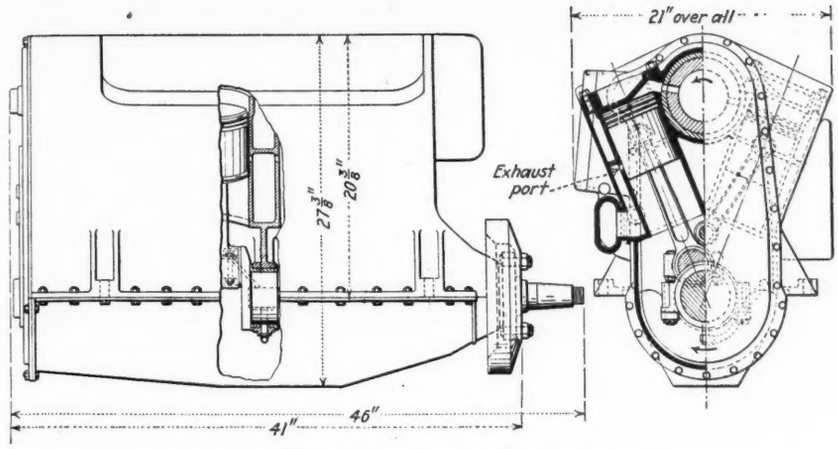


Unit has self-contained governor and is completely inclosed

governor, which is mounted on the shaft between the regulating valve and the generator. This is of the flyball type, with the balls hinged to move somewhat tangent to the shaft instead of having a true radial movement. This, it is claimed, gives the governor a quick and powerful action, resulting in good regulation over the range for which the unit is designed.

The operating parts, including the generator armature, runner and shaft, are carried on ball bearings in the generator. At the water inlet to the penstock a butterfly valve is operated by a worm gear and can be set at any desired opening. A tapered draft tube connects the plant with the tail water.

The unit is available in four regular sizes of ½-, 1-, 3-, and 5-kw. capacity, suitable for water heads from 8 ft. to 21 ft. Special sizes can also be furnished for higher heads.



General outline and partial cross-section of engine

High-Pressure, Multi-Cylinder V-Type Steam Engine With Rotary Valve

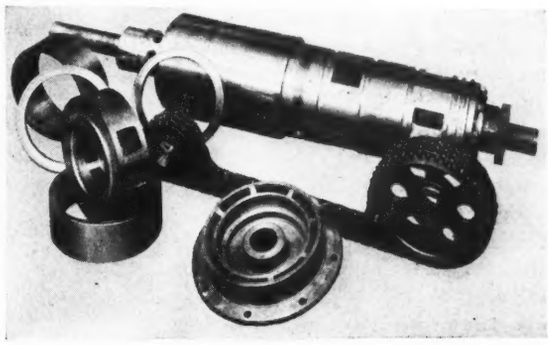
THE important advantages of the internal-combustion type of engine, such as small size, and comparatively light weight for a given horsepower, and, in addition, the ability to operate at a wide range of speeds and pressures, have been made available in the multi-cylinder V-type, single-acting, uniflow-exhaust steam engine illustrated. The unit, which has been recently brought out by the Baker Motors, Inc., 17 East 42d St., New York City, a subsidiary of the General Syndicate, Inc., has a rating of 45 hp. at 150 lb. pressure and 400 r.p.m., and a rating of 240 hp. at 300 lb. pressure and 1,500 r.p.m. Correspondingly higher horsepowers are developed with higher pressures, the engine being designed for pressures up to 1,000 pounds.

The unit consists, essentially, of eight cylinders ($4\frac{1}{2}$-in. bore and 5-in. stroke) laid out in a 45-deg. angle, with four cylinders on each side and with a rotary valve housing integral with the engine block lying between the two rows of cylinders. A 4-in. counterbalanced crankshaft is carried in five oversize bearings, with a crank throw occupying each of the spaces between the bearings. The lower end of one of each pair of connecting rods connects directly to the crank, and its mate is connected to it close to the crank-pin bearing. A stub shaft attached to the power end of the crankshaft precludes possibility of damage to the crankshaft from sudden overload or other interruption in the operation of the machine or unit to which the engine is direct-connected by means of a coupling or reduction drive.

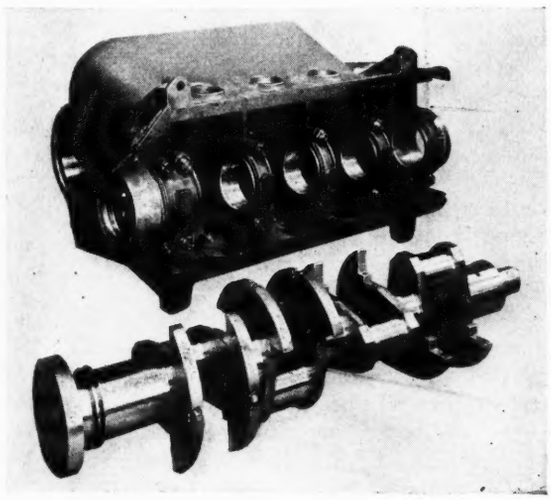
The outstanding feature of the engine is the type of steam-admission valve used. The valve is essentially a rotating steam chest mounted in a roller bearing at each end. The valve rotates in the opposite direction to the crankshaft and at half its speed, and admits steam to the cylinders through ports at opposite angles in the valve, as shown in the illustration. The use of roller bearings to carry the valve permits it to rotate freely within the housing with a minimum clearance and without frictional wear. Specially designed sealing rings, which it is claimed by the manufacturer improve with use, prevent lateral flow of steam along the valve.

Provision is made in the design of the valve-operating mechanism to permit of varying the lead, and, consequently, the compression, to give the best operating performance at the wide range of speeds, 50 to 2,000 r.p.m., at which the engine is capable of operating. Provision is also made for varying the cutoff. This feature permits of changing the horsepower and torque characteristics of the engine to suit the steam pressure and service with which the engine is being used. The chain drive for the valve is entirely inclosed at the front of the engine, as is also the oil pump for supplying oil to the main bearings, cranks, wristpins, cylinders, and other moving parts.

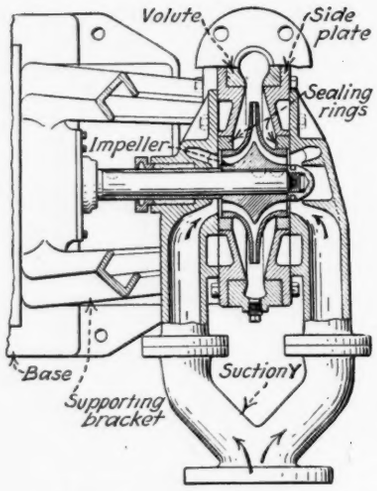
The new unit is adaptable to a wide range of application where high torque at extremely low speed is required or where high speed or two or more speed ranges are used. It can be operated from a central steam supply at pressure from 100 to 1,000 lb., or with its own steam generator. It is applicable to group drive in plants, as well as to automotive and other industrial uses.



Partial assembly of steam admission valve with casing and seal rings



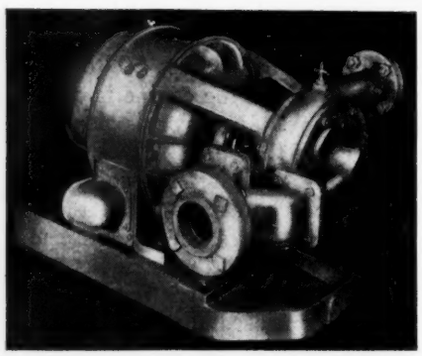
Cylinder block with bearing assembly, also four-throw counter-balanced crankshaft



Detail of pump construction

Unitype Double-Suction Centrifugal Pump

BUILT in several sizes for capacities ranging from 75 to 500 gal. per minute, the Jennings double-suction centrifugal pump illustrated, put out by Nash Engineering Company, South Norwalk, Conn., embodies unit construction. The pump and motor are built together, with four brackets integral with the motor end shield supporting the pump casing. The extended motor shaft, with bronze protecting sleeve, carries the centrifugal impeller, the only bearings in the unit being those in the motor. This design tends to insure permanent alignment and permits full accessibility, as well as obviating the



Pump is supported from motor end shield

use of a flexible coupling. The pump is bronze fitted throughout and has bronze solid sealing rings.

As will be apparent from the sectional view, the suction is connected to the inner and outer heads through a common Y-connection. As the heads as well as the volute are bolted to the side plates, as indicated in the section, the suction and discharge can be arranged to best meet installation requirements.

New Indicating Frequency Meter

THE design of the type SY frequency meter illustrated, having a scale range of plus or minus 2 cycles for 60-cycle work, differs from the usual resonance type of ratio instruments in that a single resonant circuit of the parallel type is employed. The circuit design is such that the change of resistance of the reactors and coils due to temperature variations produces no effect whatever. The indication depends only on the values of inductive and capacitative reactance. Thus the temperature effect is so small that it can hardly be measured.

The ranges obtainable are from 54 to 66 cycles and from 58 to 62 cycles

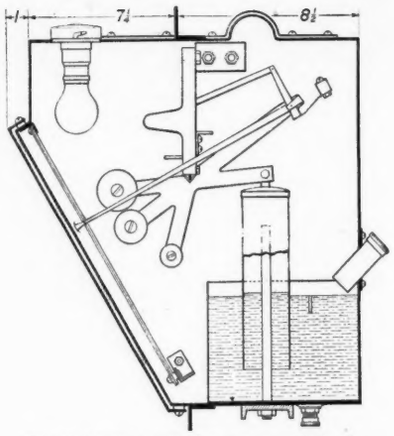
Type SY frequency meter

for use on 60-cycle systems. The instrument is put out by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Straight-Line-Movement Tilted-Front Draft Gage

TO MEET the trend in central stations and in large industrial plants to mount draft gages at high elevations, the Ellison Draft Gage Company, 214 West Kinzie St., Chicago, has brought out recently a new tilted-front gage. It is made in three types of mountings: flush front, semi-flush, and wall, in one to twelve pointers. The accompanying illustration shows the semi-flush type. With the exception of the tilted feature, the gage is essentially of the same construction as the Ellison straight-line vertical gage of the gasometer - bell, beam - and - pointer type.

The front is tilted forward 30 deg. by advancing the pointer the same



Straight-line tilted-front semi-flush panel-type gage

sequence ahead of the beam of the bell, which travels 20 deg. above and below the horizontal, as in the vertical-front type.

The movement consists of a system of compensating arcs and angles with all moments in counterbalance, which provides a straight-line pointer movement over the entire range of a straight scale of uniform spacings.

Portable Industrial Vacuum Cleaner

DESIGNED especially for heavy-duty work in cleaning machinery, motors, overhead pipes, girders and other industrial applications, the Model 70, "Tornado" industrial vacuum cleaner illustrated is of the portable tank type. It is equipped with universal ball-bearing motor mounted on a cast aluminum cover

Model 70 industrial vacuum cleaner

which fits over a steel tank. An important feature is the possibility of removing the motor from the cover to be used as a portable blower.

The cleaner is put out by the Breuer Electric Manufacturing Company, 852 Blackhawk St., Chicago, Ill.

NEWS of the FIELD

Spot News

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DISMISSING *all exceptions to the recent report filed by Charles Evans Hughes as special master in the Chicago water diversion case, the United States Supreme Court in its decision of April 14 upheld the master's recommendations giving the Chicago Sanitary District until 1938 to complete sewage disposal plants and then be permitted to divert only 1,500 sec.-ft. from Lake Michigan for navigation in addition to domestic pumpage.*

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THE NORRIS BILL, *providing for government operation of Muscle Shoals, was shelved April 15 by the House Committee on Military Affairs, and a sub-committee was appointed to draft a new measure. A few days before this Representative Douglas of Arizona introduced a new bill providing for presidential leasing of the Shoals for a term not to exceed 50 years, which may be taken as the basis for the new House measure. Since the Senate favors the Norris bill and will probably block a private leasing act, indications are that there will be no Muscle Shoals legislation at this session.*

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A NEW TYPE *of turbine-generator, which has one generator and three steam turbine elements all mounted on a single shaft, is being built for the Superpower Company of Illinois by the General Electric Company. Known as triple tandem compound turbine-generators, two of these, each rated at 105,000 kw., will be installed in the Powerton generating station.*

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DESPITE OPPOSITION, *the bill authorizing an appropriation of $350,000 for the construction and equipment of a National Hydraulic Laboratory has passed both the House and Senate. It now goes to conference over two amendments added by the House, and since it has the approval of President Hoover, it will probably become a law within a few weeks.*

Plan Erection of Temple of Power at Chicago World's Fair

Quarter-size models of steam, hydro-electric and internal combustion power plants to be exhibited

A CIRCULAR BUILDING of monumental proportions, possibly several hundred thousand feet in area, to contain a series of theatres with revolving stages, has been proposed for the power and electrical exhibits at the Chicago World's Fair in 1933. The proposal is contained in a report made by a group of leading electrical engineers to Dr. Frank B. Jewett, president of the Bell Telephone Laboratories, who is chairman of the National Research Council Science Advisory Committee, under the auspices of which the science exhibit plans for the exposition are being developed.

The sponsors of the plan have suggested that the building be called the Temple of Power.

It is planned to show exhibits of electric generation at one end of the building; at the other end, it is expected that all the various applications of electricity in the home and in industry will be shown. The space between these two is to be devoted to exhibits showing transmission, conversion and distribution of electricity. Utilization exhibits will be exhibited on the rotating stages, which are considered the most prominent feature of the Temple of Power. The generation exhibits will be mainly in the form of quarter-size models and will show equipment from coal pile, river or oil tank, to switchboard. It is planned to show a steam station with all of the principal auxiliaries, a hydro-electric station, and also an internal combustion plant. Some of the models will be cut away to show the interior construction. It is proposed to show in some form or another all the latest improvements in prime movers, this feature of the exhibits to be carried out in co-operation with the exposition's mechanical engineering committee.

On balconies suitably located with reference to the generation and distribution exhibits will be the science background and historical exhibits relating to the application exhibits on the main floor, the report states. The historic background exhibits will include many models of earlier plants.

Members of the electrical engineering committee include: R. F. Schuchardt, chairman; W. A. Durgin, John F. Gilchrist, E. W. Lloyd, L. A. Ferguson, all of the Commonwealth Edison Company of Chicago, H. W. Fuller, Byllesby Engineering & Management Corporation, Chicago; Samuel Ferguson, Hartford Electric Light Company, Hartford, Conn.; H. A. Barre, Southern California Edison Company, Seattle, Wash.; T. D. Crocker, Northern States Power Company, Minneapolis; W. E. Funk, Philadelphia Electric Company, Philadelphia; C. F. Hirschfeld, Detroit Edison Company, Detroit; W. S. Lee, Duke Power Company, Charlotte, N. C.; A. H. Markwart, Pacific Gas & Electric Company, San Francisco; W. E. Mitchell, Georgia Power Company, Brooklyn, N. Y.; I. E. Moulthrop, Edison Electric Illuminating Company, Boston; J. C. Parker, Brooklyn Edison Company, Brooklyn, N. Y.; G. E. Quinan, Puget Sound Power and Light Company, Seattle; E. C. Stone, Duquesne Light Company, Pittsburgh; Philip Torchio, New York Edison Company; W. S. Barstow, New York City; J. L. Hecht and H. H. Field of Chicago and F. R. Moulton, Utility Power and Light Company, Chicago.

Safe Harbor Work Delayed by Bridge Inquiry

Construction work at the Safe Harbor project on the Susquehanna River is being delayed while the Federal Power Commission considers an appeal by the people of the locality urging that a condition be placed in the license under which a roadway on the dam would be provided. The matter is being investigated by Colonel Max Tyler, the commission's chief engineer.

In this connection it is being contended that it would be cheaper to construct the bridge as a separate structure and that a better crossing would be at Holtwood. Were the road to cross on the dam it would be necessary to build it on the downstream face, as the crown of the structure is to be used for traveling cranes and emergency gates. The power company has tried unsuccessfully to interest a bridge company in the construction of a toll bridge. Apparently, the traffic prospects are not sufficient to interest a commercial concern of that character.

AIRPLANE VIEW OF KETTLEMAN HILLS

Through pipe lines and a new system of distribution by liquefaction, mentioned in last week's issue, this great new California oil field will soon be supplying the Pacific Coast with natural gas.

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74 Americans Registered for Berlin Conference

Seventy-four prominent American engineers and executives have already signified their intention of attending the second plenary session of the World Power Conference in Berlin, Germany, on June 16 to 25. Most of those registered will sail from New York City on June 4 aboard the Hamburg-American liner *Resolute*, the entire first cabin of which has been engaged for the use of Americans making the trip. The list of those registered is as follows:

E. J. Bechtel, Allied Power & Light Company, New York; John Hunter, consulting engineer, St. Louis; W. W. Jourdin of W. W. Jourdin and Company, Inc., New York; William Spencer Bowen, New York; Prof. A. G. Christie, department of mechanical engineering, Johns Hopkins University, Baltimore; Louis K. Malvern, Elgin Watch Company, Elgin, Ill.; R. D. Maxson, Public Service Company of Northern Illinois.

Stanton B. Cushing, Public Service Company of Northern Illinois; Dr. Gustav Egloff, Universal Oil Products Company, Chicago; Ely C. Hutchinson, editor of *Power;* George A. Orrok, consulting engineer, New York; Theodore W. Stemmler, Jr., president and treasurer, Stemmler and Company, engineers, New York; Charles E. Gorton, vice-president, A.S.M.E.; Arthur L. Rice, editor of *Power Plant Engineering.*

Charles W. E. Clarke, consulting engineer, United Engineers and Constructors, Inc., Philadelphia; Carl C. Thomas, United Engineers and Constructors, Inc., Los Angeles; Edward N. Trump, advisory engineer, Solvay Process Company, Syracuse, N. Y.; Charles W. Spooner, president, Spooner & Merrill, Inc., consulting engineers, Chicago; William S. Monroe, president, Sargent & Lundy, Inc., Chicago; Dr. Clayton H. Sharp, president, U. S. National Committee of International Electrochemical Commission, New York; Mrs. Lillian M. Gilbreth, Montclair, N. J.

David B. Rushmore, consulting engineer, New York; F. C. Sargent, vice-president, Charles H. Tenney & Company, Boston; Frank S. Clark, Stone & Webster Engineering Corporation, Boston; L. F. Harza, Chicago; James V. V. Colwell, New York; J. B. MacNeill, Westinghouse Electric and Manufacturing Company; Maurice Holland, director of Engineering and Industrial Research, National Research Council, New York; Edwin Burhorn, president, Edwin Burhorn Company, Bayonne, N. J.

Alvan L. Davis, research engineer, Scovill Manufacturing Company, Waterbury, Conn.; W. F. Uhl, vice-president, Charles T. Main, Inc., engineers, Boston; E. E. Woodward, president, Woodward Governor Company, Rockford, Ill.; Miss M. T. Waters, assistant to chairman, American Committee, World Power Conference, Washington, D. C.; Victor J. Azbe, consulting engineer, St. Louis; Prof. A. E. Kennelly, Harvard Engineering School, Cambridge, Mass.; Harold J. Kersten, Basic Science Research Laboratory, University of Cincinnati.

F. D. Newbury, manager, power engineering department, Westinghouse Electric and Manufacturing Company; A. J. German, chief engineer, Scovill Manufacturing Company, Waterbury, Conn.; Wensel Morava, Chicago; Reinhard Hildebrand, Webster Groves, Mo.; William Fondiller, assistant director of apparatus development, Bell Telephone Laboratories, New York; Harry Alexander, New York; James A. Powell, W. S. Barstow & Company, Reading, Pa.

F. B. Campbell, U. S. Geological Survey, Denver; A. W. Moulder, Grinnell Company, Inc., Providence, R. I.; Wylie Brown, president, National Electric Products Corporation and Habirshaw Cable and Wire Corporation, New York; James H. Buell, representing Middle West Utilities Company, Chicago; L. T. Robinson, General Electric Company; Thomas B. Whitted, New York; V. W. Montsinger, General Electric Company; Arthur P. Davis, Tashkent, Turkestan, U.S.S.R.

Harrison A. Smith, industrial division manager, Wisconsin Power and Light Company, Madison; L. W. W. Morrow, editor of *Electrical World;* P. W. Thompson, chief assistant engineer of power plants, Detroit Edison Company; Col. J. P. Jackson, New York Edison Company; Francis Hodgkinson, Westinghouse Electric and Manufacturing Company; G. W. Hamilton, vice-president in charge of hydraulic & electrical engineering, Middle West Utilities Company, Chicago; George Howard Plummer, Northern Pacific Railway Company, Seattle; Irving B. Crosby, consulting geologist, Boston.

Thomas A. Coghlan, efficiency engineer, American Gas & Electric Company, New York; Ernest J. Berg, professor of electrical engineering, Union College, Schenectady, N. Y.; Prof. Robert Sibley, University of California, Berkeley; Howard L. Tiger, New York; Dean Philip S. Donell, division of engineering, Oklahoma Agricultural and Mechanical College, Stillwater; G. B. Warren, turbine engineering department, General Electric Company; W. J. Delles, General Electric Company.

E. W. Bowler, in charge of civil engineering department, University of New Hampshire, Durham; Arthur M. Greene, Jr., Princeton, N. J.; I. E. Moultrop, chief engineer, Edison Electric Illuminating Company of Boston; Walton S. Smith, Metal and Thermit Corporation, Carteret, N. J.; C. B. LePage, assistant secretary, A.S.M.E. Standard and Technical Committees; Arthur W. Hixon, department of chemical engineering, Columbia University, New York; Frederick Attwood, vice-president, Ohio Brass Company, New York; I. F. Baker, Westinghouse Electric International Company, London.

What Actually Happened at Deepwater Station

Recently an unfortunate gas explosion occurred in the boiler room of the new Deepwater Station at Penn Grove, N. J. Various accounts of the accident were current at the time, some of these being very far from the facts. Therefore we are pleased to be able to state what actually happened.

The two boilers involved were connected to a single stack and had not been in service. They were being dried out and the internal surfaces were being cleaned and made ready for painting. A mechanical-type oil burner, using a light grade of fuel oil, had been used for this purpose, and as the boiler surfaces were comparatively cool, the oil vapors probably condensed and formed a gas pocket at the boiler outlet as well as in the breeching. The fire had been out of one of the boilers for four or five days and out of the other for about fifteen hours. The men went into the stack to clean and apply a protecting coating to both the stack and the breeching. They had been inside about fifteen minutes when the gas explosion occurred.

Everyone had been cautioned against the use of matches or open lights, but it is assumed that either the flame from a match or the spark from a light cord ignited the gas pocket. Both the explosion and the resulting fire were slight and no damage was done to the equipment.

New 60,000-Kw. Steam Plant for Wisconsin Company

Construction of a new steam generating station for the Wisconsin Power & Light Company on the western shore of Lake Michigan at Sheboygan, Wis., has been started by the L. E. Myers Company of Chicago. The structure will be of a capacity to house two 30,000-kw. turbines, together with their accessories. At present only one unit will be installed.

The water for condensing purposes will be taken from the lake. It will be necessary to build a bottle-shaped intake well about 1,500 ft. from the shore line.

A.S.R.E. to Hold Meeting in Atlanta, May 7-9

On May 7, 8 and 9 the American Society of Refrigerating Engineers holds its first Southern convention, in Atlanta, Ga., with headquarters at the Atlanta-Biltmore Hotel. Pertinent subjects of interest to all refrigerating men will be discussed on this occasion, the seventeenth spring meeting of the society. The members in Atlanta will be the hosts of the society through a local committee under C. Thomas Baker, consulting engineer of that city.

Technical meetings will be confined to the mornings of the three days, with numerous entertainment features and inspection trips arranged for the afternoons. A banquet and dance is scheduled for Thursday evening for which special Southern entertainment has been arranged.

The technical program starts on Wednesday morning, with the general topic of "Low Temperature Refrigeration Problems," under which will be considered: "Tests on Solid CO_2 and Water Ice," "Latent Heats of Common Edibles," "Low-Temperature Refrigeration for Retail Merchants," "Low-Temperature Display Cases," and "Refrigeration and the Fisheries."

The Thursday morning session will be devoted to "Refrigerating Machinery and Equipment," with the following papers: "Automatic Refrigerant Controls," "Tests on Refrigerating Low Sides," "Manufacturing and Design Problems in Domestic Machine Development," "Vacuum as an Insulator," and "Application of the A.S.R.E. Refrigerator Test Code."

On Friday morning the topic will be "Refrigerating Plants and Applications," discussed under the following headings: "Aspects of Refrigeration in Candy Manufacture," "Frozen Fruits a Factor in Marketing Surplus Products," "Value of Uniformity in Plant Design," "Some Railroad Problems in Perishable Shipment," and "Practical and Ideal Refrigerants."

Railway Fuel Association Meets in Chicago, May 6-9

The 22nd annual convention of the International Railway Fuel Association will be held from May 6 to 9 in Chicago, Ill., at the Hotel Sherman. Subjects scheduled for discussion at the technical sessions include mechanical improvements in locomotives, operation of prime movers, fuel handling and power plants.

At the mechanical session on Tuesday afternoon, reports will be heard on the latest developments in steam-turbine locomotives, Diesel locomotives, grates and economy devices. This will be followed on Wednesday with sessions on coal- and oil-locomotive firing practice. Reports on the inspection and preparation of coal and on fuel bulletins will be heard on Thursday morning.

On Thursday afternoon reports will be presented on fuel distribution and statistics, classification of coal, and the storage of coal and oil. At this session J. C. Nolan, fuel engineer of the Gulf Coast Lines, will give a paper on "Texas Lignite." Fuel stations and coal- and oil-fired power plants will be discussed on Friday morning, after which the convention will close.

News of Canada

Ontario to purchase 100,000 hp. from Abitibi—Conference held on pressure vessels —Features of Railways' plant

THE Ontario Hydro-Electric Power Commission has contracted to purchase 100,000 hp. of electric energy from the Hudson's Bay Power Company, a subsidiary of the Abitibi Power & Paper Company. The contract involves the building by the Abitibi company of a $23,000,000 power development on the Abitibi River, 63 miles north of Cochrane, Ont., and the construction by the hydro commission of a transmission line to Sudbury, where the new power will be available to take care, primarily, of the ever-increasing expansion in mining operations. Completion of the development and delivery of power is expected in the late fall of 1931. The contract will necessitate the construction of a branch line from the Temiskaming and Northern Ontario Railway to the Abitibi power sites.

REPRESENTATIVES of local engineering firms and officials of the Provincial Department of Labor met in conference recently in the offices of the Provincial Board of Examiners pressure vessel section), Montreal, Que., to discuss and improve the Canadian Interprovincial regulation for the construction of steam boilers and pressure vessels, to be brought up at the interprovincial conference, which

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A.S.M.E. ANNIVERSARY DINNER IN WASHINGTON, D. C.

With engineers from all parts of the world in attendance, this banquet at the Mayflower Hotel on April 8 was the climax of the 50th anniversary celebration of the American Society of Mechanical Engineers. The speakers included President Hoover, Dr. Robert A. Millikan and Charles Piez.

is to be held at Calgary on May 5.

The meeting was opened by Louis Guyon, deputy minister of labor for the province, who assured those present that the provincial government was heartily in favor of amending and improving sections of the regulations.

AMONG RECENT extensive improvements carried out at the Point St. Charles shops of the Canadian National Railways was the erection of an up-to-date power house, which contains many interesting features. Four pulverizers, in front of the boiler, each have a capacity of 6,000 lb. per hour; the boiler has a capacity of 185,000 lb. of steam per hour at a temperature of 375 deg. F. Its weir-type centrifugal boiler-feed pump has a capacity of 480 gal. per minute, against 400 lb. pressure.

Located on the south side of the locomotive shop, the power house consists of a four-story red brick building with reinforced concrete foundations. A water tank is provided having a capacity of 150,000 gal. The engine room equipment consists of one 1,000-kw., direct current Belliss-Morcom turbine-generator, one 500-kw., alternating current steam-driven auxiliary generator, two Belliss-Morcom steam-driven air compressors with a capacity of 2,500 cu.ft. free air per minute, and Westinghouse switch boards.

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Obituary

DR. THOMAS ADDISON, who served for 31 years as Pacific Coast manager of the General Electric Company, with headquarters in San Francisco, until his retirement in 1923, died suddenly in Berkeley, Calif., April 8, at the age of 76. Educated originally as a physician, Dr. Addison was graduated from Bellevue Medical College, New York, in 1877, but after eight years gave up his practice to enter the employ of the United States Electric Company of Chicago. In 1888 he became an apparatus salesman for the Thomson-Houston Company in Chicago, and when in 1890 the western branch of the company was reorganized, he was sent to San Francisco as local manager. Two years later he became Pacific Coast manager of the General Electric Company.

ALEXANDER S. MACDOWELL, superintendent of electric generation, construction and maintenance for the Rochester Gas & Electric Corporation, was overcome by carbon monoxide gas fumes while tinkering with his automobile in the garage at the rear of his Rochester home recently and died before he could reach safety. Mr. MacDowell was well known in the electrical industry. Following graduation from the University of Rochester in 1898, he spent the next ten years acquiring practical experience, joining the Rochester utility in 1908 as an electrical engineer.

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COMING CONVENTIONS

American Society of Mechanical Engineers. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Boiler Manufacturers Association. Annual meeting at Skytop Lodge, Cresco, Pa., May 26-28. Secretary, A. C. Baker, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineers. District meeting at Springfield, Mass., May 7-10. Annual summer convention at Toronto, Canada, June 23-27. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Order of Steam Engineers. Annual convention and mechanical exhibit at the Grand Fraternity Building, 1626 Arch St., Philadelphia, Pa., June 9-12. Secretary, William S. Wetzler, 6033 Jefferson St., Philadelphia, Pa.

American Society of Heating & Ventilating Engineers. Annual summer meeting at the Curtis Hotel, Minneapolis, Minn., June 23-25. Secretary, A. V. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Annual spring meeting at the Atlanta Biltmore Hotel, Atlanta, Ga., May 7-9. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at Haddon Hall, Atlantic City, N. J., June 23-27. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Refractories Institute. Annual spring meeting at The Greenbrier, White Sulphur Springs, W. Va., May 19-20. Secretary, Dorothy Texter, 2202 Oliver Bldg., Pittsburgh, Pa.

Association of Iron and Steel Electrical Engineers. Annual convention and iron and steel exposition at Broadway Auditorium, Buffalo, N. Y., June 16-20. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

International Railway Fuel Association. Annual meeting at the Hotel Sherman, Chicago, Ill., May 6-9. Secretary, C. T. Winkless, Room 700, LaSalle St., Station, Chicago, Ill.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Oil and Gas Power Meeting, under auspices of A.S.M.E. Oil and Gas Power Division and Pennsylvania State College, will be held at State College, Pa., June 12-14. Chairman, L. H. Morrison, c/o *Power*, 10th Ave. and 36th St., New York City.

National Power Show. Held in connection with the International Textile Exposition at Mechanics Building, Boston, Mass., April 28 to May 3. For information, write to the New England Association of Commercial Engineers, 53 Devonshire St., Boston, Mass.

Second Plenary World Power Conference. Convenes at Berlin, German, June 16-25. Chairman of the American Committee, O. C. Merrill, Edmunds Building, Washington, D. C.

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Personals

VICTOR J. AZBE, consulting engineer of St. Louis, sailed on April 12 for Hamburg to be gone three months in the interests of several clients. While in Germany he will attend the World Power Conference where he will present a paper on smoke abatement. He will visit Germany, Denmark, Sweden, Norway, England, Scotland, Holland, France, Switzerland, Austria, Hungary, Italy, Roumania, Greece and Turkey.

R. J. BENDER has recently been appointed combustion engineer in charge of development work for the Grindle Fuel Equipment Company, a subsidiary of the Whiting Corporation of Harvey, Ill. For the past ten years Mr. Bender has been connected with the pulverized-coal field in America and abroad.

DR. P. W. BRIDGEMAN, head of the department of physics at Harvard University, Cambridge, Mass., has been appointed a member of the recently created scientific advisory board of the Westinghouse Research Laboratories in East Pittsburgh, Pa. Dr. Bridgeman has done extensive research work in connection with high pressures, his scientific achievements having won him the Rumford medal of the American Academy of Arts and Sciences in 1917.

C. A. TERRY has been appointed superintendent of hydro stations for the New York Power & Light Corporation with headquarters in Albany. In his new position he will have direct supervision of the company's eighteen hydro-electric stations. He has been associated with hydro-electric development in various parts of the country.

SIR HARRY HAWARD retired from the office of British Electricity Commissioner March 31, on completion of his extended term of office. Sir Harry, who is 67 years of age, is one of the original five Electricity Commissioners appointed in 1920.

CHARLES C. EGBERT, consulting engineer of Niagara Falls, N. Y., has been appointed by Governor Roosevelt to succeed Paul A. Schoellkopf as a member of the Commission for the Niagara State Reservation.

OSCAR G. THURLOW, chief engineer of the Alabama Power Company, and A. C. POLK, president of the Dixie Construction Company, have been named vice-presidents of the recently organized Allied Engineeds, Inc., of New York.

GERARD H. MATTHEWSON, hydro-electric engineer attached to the United States Engineers' Office at Norfolk, Va., is at Danville, Va., making arrangements for a survey of the Dan River, to be started in May. The course of the stream will be plotted by aerial photography and a ground survey will also be made showing sites for power dams.

Business Notes

STANDARD MANAGEMENT AND OPERATING CORPORATION, San Francisco, Calif., has recently been formed by the Standard Oil Company of California to supervise the operation and development of public utilities and industrial establishments. Under its management are the Pacific Public Service Company, Coast Counties Gas & Electric Company, California Consumers Company, California Consolidated Water Company, Coast Natural Gas Company and other public utility properties. Closely identified with the major projects of natural gas development in northern California, the Standard corporation has facilities to handle extensive engineering work.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., reports that orders received for the first quarter of 1930 amounted to $90,397,731, compared with $101,365,208 for the corresponding three months of last year. Sales billed totaled $91,205,732 compared with $83,385,015 for the first quarter of 1929, and profit available for dividends was $14,398,791 compared with $13,862,298 for the same three months last year.

F. W. PENNOCK & COMPANY, Montreal, Que., announce the removal of their offices from the Imperial Theatre Building to 632 Craig Street West.

FOOTE BROS. GEAR & MACHINE COMPANY, Chicago, Ill., announces the appointment of a new representative, Sutor & Company, 2008 East Slauson Ave., Los Angeles, Calif, for the southern California territory.

CHAIN BELT COMPANY, Milwaukee, announces the appointment of the following new exclusive distributors of its products: Corbin Supply Company of Macon, Ga.; J. D. Adams Manufacturing Company, Indianapolis, Ind.; and R. B. Everett Company of Houston, Texas.

AMERICAN MANGANESE STEEL COMPANY, Chicago, Ill., announces the election of A. W. Daniels as vice-president in charge of sales.

AMERICAN AIR FILTER COMPANY, Inc., Louisville, Ky., is the new name under which the companies formerly operating as Reed, Midwest and National Air Filter Companies have consolidated and will henceforth function as one organization.

JAMES T. CASTLE, merchant engineer of Pittsburgh, Pa., announces the removal of his office to larger quarters at 424 First Avenue.

THE TERRY STEAM TURBINE COMPANY, Hartford, Conn., announces the election of J. D. Stout as vice-president. Mr. Stout has been associated with the Terry company since 1909 in connection with sales and engineering activities.

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With the SOCIETY SECTIONS

A.S.M.E., Metropolitan Section. Inspection of Macy's plant, 34th St. and Broadway, New York, on April 30 at 7 p.m. Meeting at 8:15 p.m. in the Engineering Societies Building. Sponsored by the A.S.M.E. Oil and Gas Power Division. Subject: "Diesels in Store Buildings," by George Pogue, Eastern sales manager, Fulton Iron Works Company.

A.S.M.E., Philadelphia Section. Meeting at Engineers Club on April 22 at 8 p.m. Subect: "Design and Construction of Deepwater Power Station," by K. M. Irwin, mechanical engineer, United Gas Improvement Company.

A.S.M.E., St. Joseph Valley Section. Inspection of Twin Branch Super-Power Plant at 4 p.m., May 8. Dinner meeting at 6:30 p.m. Subject: "The Character of Metals as Determined by X-ray Micro Photography," Prof. G. L. Clark, University of Illinois.

New England States Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the State Armory, Salem, Mass., June 19-20, 1930. Secretary, E. S. Daniels, 113½ Bridge St., Salem, Mass.

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Trade Catalogs

TURBINES — Characteristics, advantages, construction features, regulation and installation of Kaplan automatically adjustable blade hydraulic turbines are described in detail in Bulletin No. 123 recently published by the S. Morgan Smith Company, York, Pa. Profusely illustrated in color, this 24-page booklet also contains an interesting history of the development of the Kaplan turbine.

STEAM TRAPS—A detailed description of Armstrong steam traps is contained in a 36-page, illustrated catalog (F) recently issued by the Armstrong Machine Works, Three Rivers, Mich. Included in this bulletin are tables of sizes and prices, engineering data, and general information on the installation and maintenance of steam traps.

PIPES — An attractively prepared, fully-illustrated, 32-page bulletin has just been issued by the Republic Iron & Steel Company, Youngstown, Ohio, on Toncan iron pipe. General information is given on the development, advantages, resistance to corrosion, and many applications of this piping.

CRANES—Specifications of the Wright dynamic lowering circuit with the new magnetic controller for crane hoists are given in a recent folder of the Electric Controller & Manufacturing Company, Cleveland, Ohio.

REGULATORS — Two new folders, printed in color, have recently been issued by the Northern Equipment Company, Erie, Pa. One describes the Copes Type DS pump governor, while the other tells the story of the Copes Type RG feed-water regulator, which controls both differential water pressure and amount of flow.

WELDING—Facts concerning welding wire research are contained in a new publication of the Page Steel & Wire Company, 230 Park Ave., New York City. It tells why ordinary wire will not do for welding, and the effects of impurities on the finished weld. Data concerning the use of a proper flame and welding current are given in detail. The book also shows how to test welding wire by the flame test.

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Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.20 @$2.30
Kanawha	Columbus	1.35 @ 1.50
Smokeless	Cincinnati	1.75 @ 2.25
Smokeless	Chicago	1.75 @ 2.25
S. E. Kentucky	Chicago	1.25 @ 1.60
Steam	Pittsburgh	1.40 @ 1.65
Gas Slack	Pittsburgh	1.00 @ 1.20
Big Seam	Birmingham	1.60 @ 1.75
Anthracite (Gross Tons)		
Buckwheat	New York	$2.50 @$3.00
Barley	New York	1.40 @ 1.50

FUEL OIL

New York—Apr. 17, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Apr. 9, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.495 per bbl., or 42 gal.; 26@28 deg., $1.595 per bbl.; 28@30 deg., $1.695 per bbl.; 30@32 deg., $1.745 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 37@40 deg., distillate, 4.98c. per gal.

Pittsburgh—Apr. 9, f.o.b. local refinery, 30@34 deg., fuel oil, 4.37½c. per gal.; 36@40 deg., 4.37½@4.5c.

Philadelphia—Apr. 9, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati—Apr. 8, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Apr. 8, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 80c. per bbl.; 26@30 deg., 90c.@95c. per bbl.; 30@32 deg., $1.05@$1.10 per bbl.

Boston—Apr. 14, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.3c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Apr. 12, f.o.b. local refinery 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ala., Gadsden—Missionary Servants of the Blessed Trinity will soon award contract for the construction of a 9 story hospital including steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc. Estimated cost $700,000. Schmidt, Garden & Erickson, 104 South Michigan Ave., Chicago, Ill., are architects.

Ark., Little Rock—S. McGehee Construction Co., Rector Bldg., Owner and Builder, plans the construction of a 14 story hotel, including steam heating, ventilation and refrigeration systems, elevators, etc., at Main and Markham Sts. Estimated cost $600,000. Wittenberg & Delany, Home Insurance Bldg., are architects.

Calif., Orange—Consolidated Orange Growers Association, is having plans prepared for the construction of a 3 story, 70 x 90 ft. pre-cooling plant on Orange St. to Gay Engineering Corp., 2650 Santa Fe Ave., Los Angeles. Estimated cost $75,000.

Calif., Sacramento—J. M. Dean, City Mgr., recommended $688,000 bond issue for additions and repairs to filtration plant, to include new 70 m.g.p.d. sedimentation basin, repairing existing sedimentation basin, and addition of extra pumps.

Conn., Norwalk—Hain Bros., Meadow St., is having revised plans prepared for the construction of a 1 story, 55 x 150 ft. ice manufacturing plant. Estimated cost $40,000. H. E. Koerner, 83 Fairfield Ave., Bridgeport, is architect.

Conn., Norwalk — Second District Electric Light Co., awarded contract for the construction of an electric power plant on State St. to M. J. Riordan, Hoyt and Clard Sts. Estimated cost exceed $50,000.

Conn., South Norwalk — Norwalk Electric Light Co., State St., awarded contract for the construction of a 1 story, 48 x 65 ft. power plant including electric generator and Diesel engine to M. J. Riordan, Hoyt St. Estimated cost exceed $40,000.

D. C., Washington—Bureau of Yards & Docks, Navy Dept., received lowest bid for extension to boiler house at Washington Navy Yard from I. T. Brandt, $34,340.

Fla., Sebring—Guerin Investment Co., Melbourne, acquired a site and plans the construction of an ice and cold storage plant, here. Estimated cost $75,000.

Ill., Belleville — City, c/o M. C. Stegmeyer, mayor is having preliminary plans prepared for the construction of a municipal electric light and power plant and distribution system.

Ill., Chicago—Murray Hill Apartment Building Corp., 6712 North Clark St., awarded contract for the construction of a 16 story apartment building including either central refrigeration system or individual units, six electric elevators, etc. at Junior Terrace and Lake Shore Dr. to Shelby Construction Co., 6712 North Clark St. Estimated cost $1,700,000.

Mass., Norwood—Bd. of Selectmen, awarded contract for addition to electric light plant at Central and Railroad Ave. to J. Mutch, 62 Highland Ave. Estimated cost $40,000.

Mass., Springfield — Springfield Ice Co., 91 Dwight St., awarded contract for the construction of an artificial ice plant to E. F. Carlson, 1694 Main St. Estimated cost $25,000.

Mich., Detroit—A. Kahn Inc., 1000 Marquette Bldg., Archt., will receive bids about Apr. 30, for the construction of a 5 story printing plant including steam heating and ventilation systems, boilers, elevators, etc. on Lafayette Blvd. for Detroit News. Estimated cost $2,750,000.

Miss., Kosciusko — City plans an election soon to vote $20,000 bonds for extensions and improvements to water and light plant.

Miss., Yazoo City — Yazoo City Comn., is having preliminary plans prepared for addition to electric light and power plant to double capacity. Estimated cost $90,000.

N. J., Bloomfield — General Electric Co., Lawrence St., is receiving bids for the construction of an electric substation. Estimated cost $40,000. Private plans.

N. J., Hillsdale — Dept. of Institutions & Agencies, State House Annex, Trenton, will receive bids until Apr. 28 for the construction of boiler settings and smoke breeching for two 400 hp. boilers and installing service distribution piping at Hillsdale Hospital. Estimated cost $25,000. C. N. Leathem, Jr., c/o Dept. of Architecture & Construction, State House Annex, Trenton, is engineer.

N. J., Jersey City—Harris & Sohn, 58 Park Pl., Newark, Archts., will receive bids about May 15, for the construction of a 10 story medical office building including steam heating and ventilation systems, boilers, elevators, etc. at Tonnelle and Sip Aves. for Journal Sq. Medical Building Inc., W. J. Quinn, c/o Dept. of Revenue and Finance, City Hall. Estimated cost $1,000,000.

N. J., Jersey City—W. Neumann, 26 Journal Sq., Archt., will receive bids about May 15, for the construction of a 15 story office and stores building including steam heating and ventilation systems, boilers, elevators, etc. at Newark and Oakland Aves. for Spingarn Realty Co., 591 Summit Ave. Estimated cost $750,000.

N. J., Jersey City—Public Service Electric & Gas Co., 80 Park Pl., Newark, awarded contract for the construction of a 1 story electric substation at 324 Palisade Ave., to Public Service Production Co., 80 Park Pl., Newark. Estimated cost $40,000.

N. J., Millburn—Township Committee, is having plans prepared for the installation of a sanitary sewage system including pumping station. Estimated cost $25,000. E. R. Halsey, 79 Academy St., Newark, is engineer.

N. J., Trenton—State Bd. of Education, State House Annex, will receive bids about May 1, for the construction of a 2 story, 48 x 58 ft. power plant at Lake Blvd. between Pennington and Ewingville Rds. Estimated cost $75,000. Guilbert & Betelle, 20 Branford Pl., Newark, are architects.

N. Y., Brooklyn — Dept. of Water Supply, Municipal Bldg., New York, will receive bids about June 1, for the construction of a waterworks pumping station at West 24th St. and Neptune Ave., here. Estimated cost $150,000 M. D. Metcalf, Bedford and Atlantic Aves., is architect.

O., Cleveland—John Carroll University, B. J. Rodman, Pres., West 30th St. and Carroll Ave., plans the construction of a group of buildings including power house, etc. on Pemberton Rd. Estimated cost $2,500,000. P. L. Small & Associates, Terminal Tower, is architect.

Okla., Geary—City plans an election Apr. 29 to vote $40,000 bonds for waterworks improvements including pumping equipment, mains, etc. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Tenn., Nashville—Meharry Medical College, C Nelson, Chn., 112 Maple St., received lowest bid for the construction of a group of buildings including 35 x 53 ft. boiler house, etc. from Angle-Blackford Co., Greensboro, N. C. $1,344,000. Gordon & Kaelber, 311 Alexander St., Rochester, N. Y., are architects.

Tex., Port Arthur—City is having preliminary surveys made for a municipal light and power plant. Estimated cost $75,000. Address C. B. Moore, Finance Comr.

Wash., Centralia—City will receive bids until Apr. 29 for completion of hydro-electric project on the Nisqually River to include the control structure on the River near Yelm, also transmission line, substation in Centralia, power house, forebay, penstock, tailrace, switchboards, oil current breakers, transformers, flume and lightening arresters. Estimated cost $400,000. Total estimated cost $1,000,000. Contract for transformers previously awarded to General Electric Co., Colman Bldg., Seattle, declared void.

Ontario—Hudson Bay Power Co., subsidiary of Abitibi Power & Paper Co., Cochrane, plans the construction of a hydro-electric development on the Abitibi River, 63 miles north of Cochrane, also transmission line in Ludbury. Estimated total cost approximately $26,000,000 Completion of development and delivery of power expected late in 1931.

Equipment Wanted

Air Compressor — Boston, Mass. — Welding Co., 1259 Dorchester Ave., plans to purchase electric driven air compressor for garage.

Air Compressors, etc.—Washington, D. C.— A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until May 1, for electric air compressors, etc. for overhaul of Panama Canal locks.

Boiler—Boston, Mass.—Metropolitan District Commission, Water Division, I Ashburton Pl., will receive bids until May 1 for vertical fire boiler 98 in. in diameter and 24 ft. high for working steam pressure of 185 lbs. per sq. inch.

Boiler and Stoker—Somerset Hills, N. J.— U. S. Veteran's Bureau, Arlington Bldg., Washington, D. C., will readvertise for bids soon for furnishing and installing boiler and stoker at U. S. Veteran's Hospital, here. Former bids rejected.

Pump—Cordell, Okla.—City, J. Killian, Supt., will receive bids until Apr. 25 for one 500 g.p.m. centrifugal pump with marine engine drive.

Pump and Motor—Tyrone, Okla.—City plans to purchase a deep well pump and motor for waterworks.

Pumping Unit—San Mateo, Calif.—City plans to purchase pumping unit in connection with sewage treatment work.

Pumps, Etc.—St. Thomas, Ont.—City plans to purchase pumps, etc. for proposed waterworks improvements. Estimated cost $100,000.

Industrial Projects

Ark., Jonesboro — Reliable Furniture Co., M. Ratinoff, awarded contract for a 1 story, 60 x 140 ft. furniture factory at Creath Ave. to John Reese, Jonesboro.

Conn., Waterbury—Lux Clock Co., 97 Sperry St., is having plans prepared for the construction of a 4 story, 35 x 80 ft. factory. Estimated cost $75,000. T. M. Freney, 51 Leavenworth St., is architect.

Ind., Indianapolis—American Can Co., 1610 Merchants Bldg., awarded contract for addition to factory including loading platform at 1936 South East St. to E. B. Ball, 1131 North Tacoma St. Estimated cost $45,000.

Ind., Mishawaka—Texas Oil Co., 332 North Michigan Ave., Chicago, Ill., awarded contract for the construction of a bulk oil station including boiler room, pump house, etc. here to Hay-Weaver Co., South Bend. Estimated cost $60,000.

La., Bogalusa — Bagalusa Paper Co., R. H. Laftman, Gen. Mgr., awarded contract for addition to paper plant to Dye & Mullins, Columbia. Estimated cost including equipment $1,000,000.

Mass., Everett (br. Boston)—Boston Varnish Co., Boston and Second Sts., awarded contract for addition and alterations to factory, 40 x 175, 40 x 115 and 40 x 85 ft., to Bond Bros., 79 Ferry St. Estimated cost $140,000 to $160,000.

N. J., Newark—P. B. West, 24 Commerce St., Archt., will receive bids about May 1, for the construction of a 2 story factory and boiler room on Maple Pl. for General Alloy Co., 188 New Jersey Railroad Ave. Estimated cost $40,000.

N. J., Passaic — U. S. Rubber Co., 211 Passaic St., awarded contract for the construction of a 6 story, 100 x 175 ft. factory No. 25 on Market St. to J. W. Ferguson Co., 152 Market St., Paterson. Estimated cost $400,000.

O., Cleveland—The Lorain Icer Co., E. J. Hart, Mgr., 3933 St. Clair Ave., manufacturers of refrigerators, awarded contract for a 2 story, 100 x 296 ft. factory at 9515 Carr Ave. to H. K. Ferguson Co., Hanna Bldg. Estimated cost $75,000.

O., Cleveland—Standard Oil Co. of Ohio, E. B. Wagoner, Constr. Mgr., East Ohio Gas Bldg., awarded contract for the construction of a wax press building on East 65th St. to The Austin Co., 16112 Euclid Ave. Estimated cost $40,000.

O., East Liverpool—Hall China Co., c/o M. Thompson, 514 East Main St., will soon award contract for the construction of a 1 story, 250 x 680 ft. pottery plant. Estimated cost $250,000. B. H. Prack, Martin Bldg., Pittsburgh, Pa., is architect.

Pa., Philadelphia—J. W. Landenberger Co., Randolph and Columbia Sts., will soon award contract for the construction of a 2 story, 76 x 309 ft. hosiery manufacturing plant at N. St. and Kensington Ave. Estimated cost $225,000. J. S. Simsohn, Broad and Girard Sts., is architect.

Tex., Houston—Midwest Piping & Supply Co. Inc., 1450 South Second St., St. Louis, Mo., awarded contract for the construction of a 1 story, 200 x 220 ft. factory at Bringhurst and Cline Sts. here to The Austin Co., Arcade Bldg., St. Louis, Mo. Estimated cost $250,000.

Wis., La Crosse — Trane Co., Second and Cameron Sts., awarded contract for the construction of a 1 story, 160 x 260 ft. factory to P. Nelson & Son, Newburg Bldg., La Crosse.

Ont., London—Jones Box & Label Co., S. F. Jones, Mgr. will soon award contract for a 3 story, 65 x 80 ft. addition to factory on Dundas St. Estimated cost $50,000. L. G. Bridgeman, Royal Bank Bldg., is architect. Equipment for the manufacture of paper boxes and printing of labels will be installed.

Ont., St. Catherines—W. S. Tyler & Co., 3615 Superior Ave., Cleveland, O. awarded contract for the construction of a 1 story factory for the manufacture of ornamental iron, screens, etc. to Newman Bros., 75 St. Paul St. Estimated cost $125,000.

Ont., Toronto—Litho-Print Ltd., 371 Adelaide St. W., is having plans prepared for the construction of a 4 story lithographing plant. Estimated cost $150,000. H. L. Allward, 119 Scollard St., is architect.

Ont., Toronto — Model Knitting Mills, 171 John St., awarded contract for masonry, etc., for a 7 story, 90 x 113 ft. mill. Estimated cost $200,000. B. Swartz, 336 Dundas St., W., is architect.

Ont., Welland — Page-Hersey Tubes Ltd., plans the construction of a new plant. Estimated cost $2,000,000.